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Timeline of Organic Chemistry

- **Berzelius Theory (1815):**
  (Vital Force Theory)

Acc" to it, it was assumed that organic compounds are obtained only from plants and animals, which means that it cannot be synthesized in laboratory.

Above theory was proved wrong by Wohler's synthesis.

- **Wohler's Synthesis (1828):**

$NH_4^+ \; N{\equiv}C{-}O^-$ $NH_4CNO \xrightarrow{\Delta} NH_2CONH_2$

Ammonium cyanate — Urea (organic cpd.)

- **What are Organic compounds?**

Compounds containing carbon with the exception of oxides, carbides, carbonates, cynides.

- **Why carbon is so special?**

It is due to special ability of carbon atom to form long chains containing C-C and other bonds known as catenation.

- Tendency for catenation decreases down the group because orbital [illegible]

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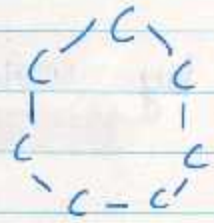
and hence overlapping is relatively poor.
Such type of chains can be formed,

C – C – C – C – C) linear

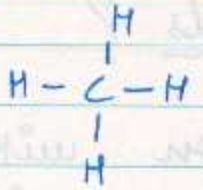
) Branched

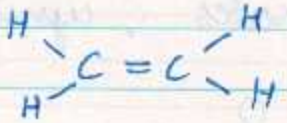
) cyclic

- Structural Representation of Organic Molecules :→

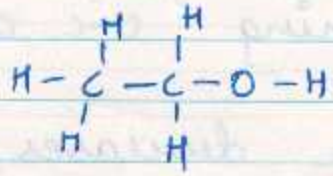
1] Complete Structural Formula :→

All atoms & bonds are shown.

CH_4 → 

C_2H_4 → 

C_2H_2 → H–C≡C–H

Ethanol → 

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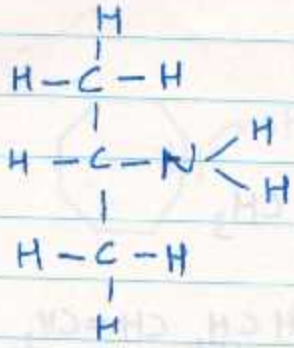
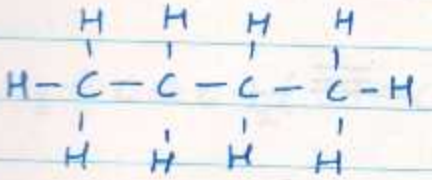
- Isopropyl amine →



-  → $CH_3CH_2CH_2CH_3$ → $CH_3(CH_2)_2CH_3$

condensed formula

- condensed — Bond line

- $CH_3CH_2CH_3$

- $CH_3CH_2CH_2CH_3$

- $CH_3CH(CH_3)CH_3$

- $CH_3C(CH_3)_2CH_3$

- $CH_3(CH_2)_4CH_3$

- $CH_3(CH_2)_4CH(CH_3)CH_3$

- $CH_3CH=CH_2$

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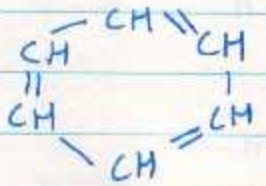
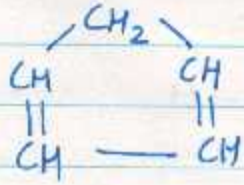
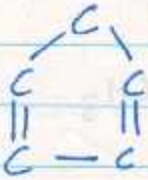
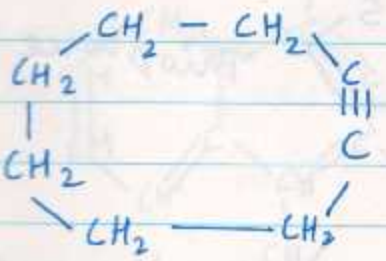
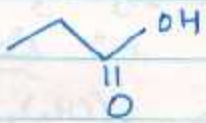
- $CH_3CH=CHCH_3$
- $CH_3(CH_2)_2(CH=CH)_2CH_3$
- $CH_3(CH_2)_4CH=CHCH_2CH=CH_2$
- $HC\equiv CH$
- $CH_3-C\equiv CH$
- $CH_3C\equiv CCH_3$
- $CH_3C\equiv CCH_2CH_2CH_3$
- $CH_3(CH_2)_3C\equiv C-CH=CH_2$
- $HC\equiv C-C\equiv CH$
- $CH_3\text{-}(C\equiv C)_2\text{-}CH_3$
-  Benzene
-  

- 

Triple (3 bond)
It is possible in bigger rings only → ≥8

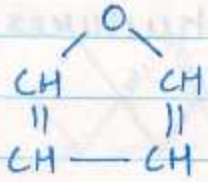
- $CH_3-(C\equiv C)_2-(CH=CH)_2-C(CH_3)_3$

- CH_3CH_2OH

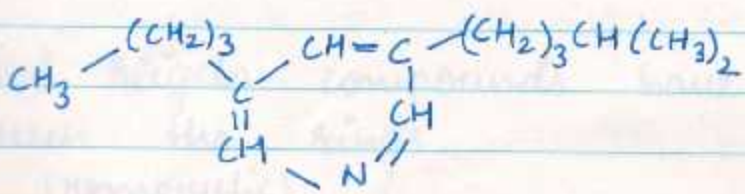
- $CH_3CH_2\overset{O}{\overset{\|}{C}}-OH$ 

- $CH_3(CH_2)_3\overset{O}{\overset{\|}{C}}-N(CH_3)_2$

- $CH_3(CH=CH)_3(CH_2)_3COOCH_2CH_3$

- 

Furan

- 

- $(CH_3)_3C\cdot C\cdot CCH_3$

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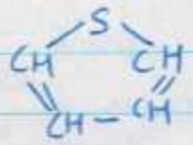
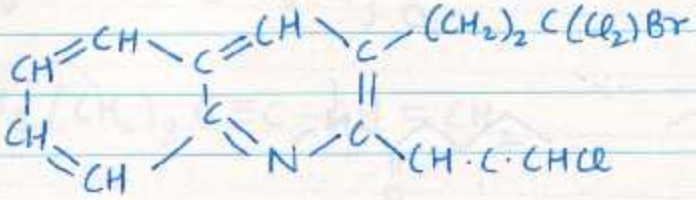
- 

- $(CH_3)_2 C \cdot C \cdot C (CH_3)_2$

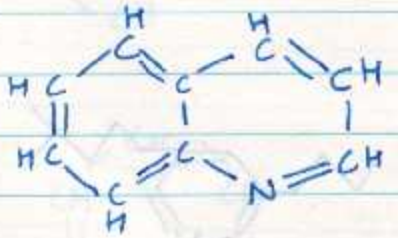
- $CH_3 (CH_2)_2 CH (OH)_2$

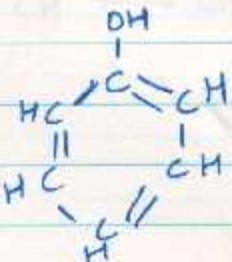
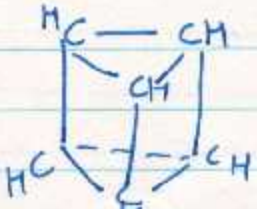
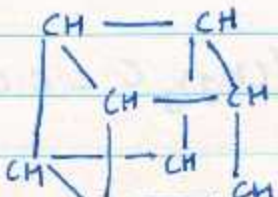
- $CH_3 C (Cl) (Br) (CH_2)_3 CH_3$

- 

- $(CH_3)_3 C (CH_2)_3 C (CH=CH_2)_2 \cdot CH_2 \overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-CH_3$

Q. convert the following bond line structures to condense form.

1)→ 

2)→ 
,

,


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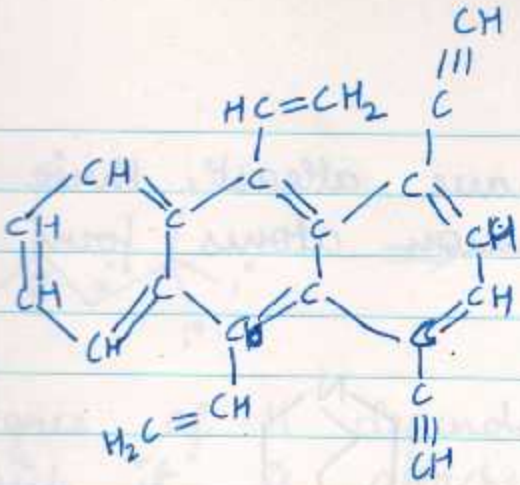
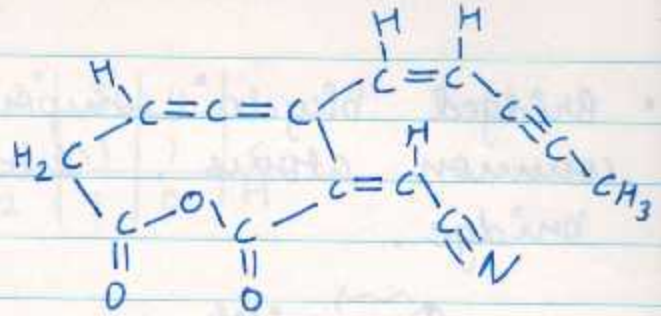
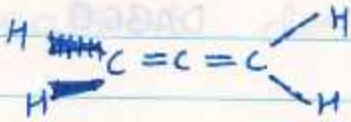
3)  , 

 ⇒ Allene

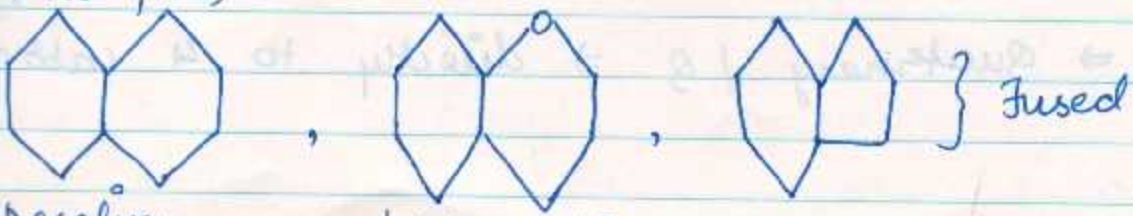
* Bicyclo & Spiro compounds :→

• SPIRO is a Bicyclo compound having 1 common atom b/w two rings.

SPIRO
↓
SPIRA
↓
TWIST

• Fused Bicyclo compounds have two common atoms between the rings.

(Homocyclic)



Decalin

} Fused

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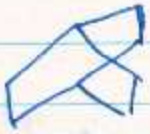
- Bridged bicyclo compounds have atleast three common atoms. Those common atoms form a bridge.

DABCO

Norbornane

Side View ⇒



* Degree of Carbon & Hydrogen :-

- 1° carbon ⇒ Primary / P ⇒ It is directly attached to 1 carbon.
  (If not attached to any still use it)
- 2° C ⇒ Secondary / S ⇒ directly to 2 carbons
- 3° C ⇒ Tertiary / T ⇒ directly to 3 carbons
- 4° C ⇒ Quaternary / Q ⇒ directly to 4 carbons

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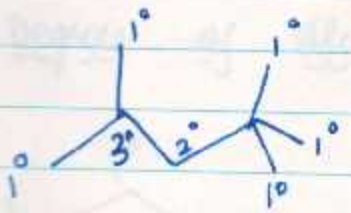


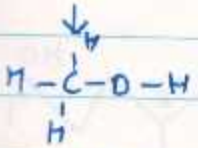
⟹

1°	2°	3°	4°	
5	1	1	1	C
15	2	1	0	H

- Degree of H depends on degree of Carbon to which it is attached
- Quartenary H is not possible & H connected to Heteroatoms does not have any degree.

Q.

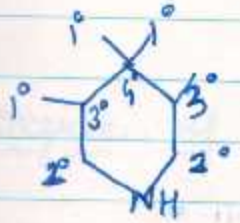
1) CH_3OH



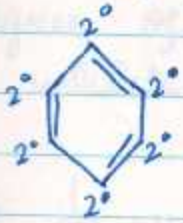
1C
3H

2)

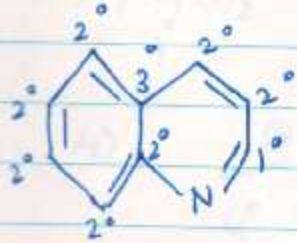
2C
5H

3) 

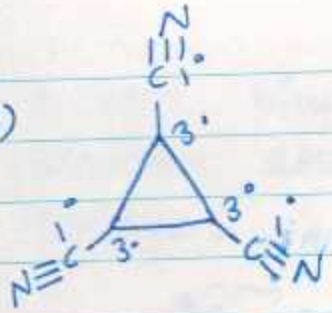
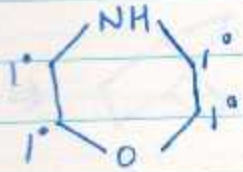
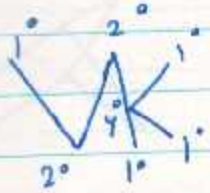
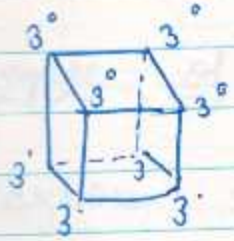
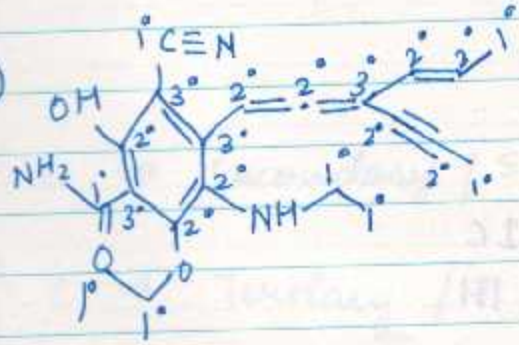
5C 2C 1C
16H 1H

4) 

6C
6H

5) 

1C 7C 1C
2H 13H 1H

	1°	2°	3°	4°
6) 	3C		3C	
			3H	
7)	4C	4C		1C
	8H	4H		
8) 	4C			
	8H			
9) 	4C	2C		1C
	12H	4H		
10) 	0		8C	
			8H	
11) 	~~8~~ 9C	9C	4C	
	16H	3H	–	

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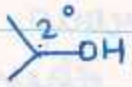
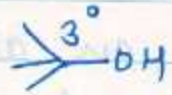
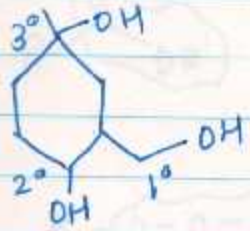
• Degree of Alcohol :→

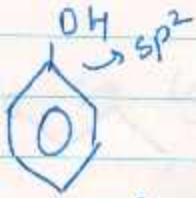
1)

Primary

2) 

3) 

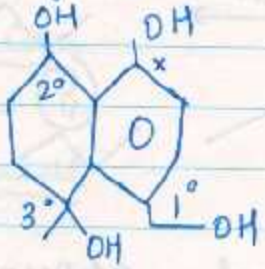
4) 

5) 

Phenol
(Not Alcohol
SO NO degree)

6)

7)

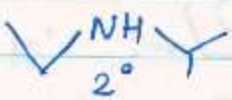
8) 

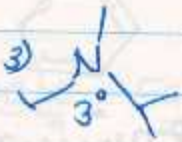
Degree of Alcohol is the degree of C - to which it is attached

• Degree of Amine :→

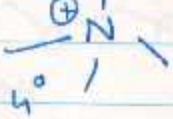
- Degree of Amine is defined as no. of C-atoms to which it is attached.

1)

2) 

3) 

They are treated as diff. functional groups (unlike alcohols)

4) 

⇒ Quaternary salt

5)

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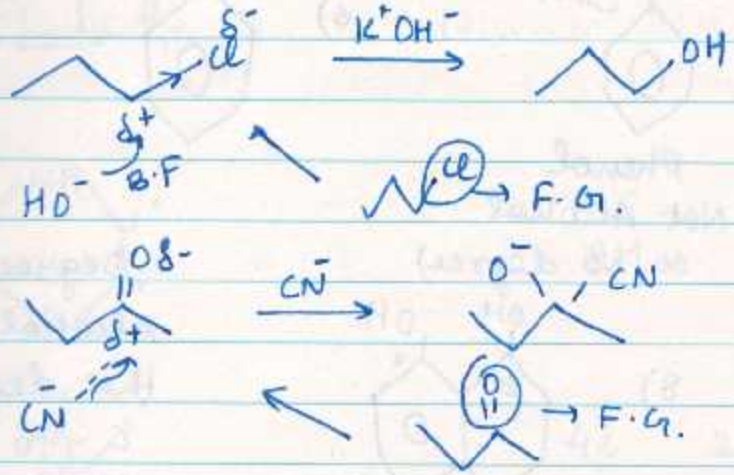
* Functional group :→

It is an atom or group of atoms which decides the physical and chemical properties of a given compound.



· List of functional groups :→

1] Alkene :→ $>C=C<$

2] Alkyne :→ $-C\equiv C-$

3] Benzene :→

Oxygen containing F.G.

R ≠ H
4] R–OH → Alcohol

R, R' ≠ H
5] Ether :→ R–O–R'

6] Aldehyde :→ R–C(=O)–H / R_{CHO}

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7] Ketone :→ / $R_{CO}R'$

8] / R_{COOH} :→ Carbonylic acid

9] / $R_{COOR'}$:→ Carbonylic Ester

10] :→ Hydro peroxide

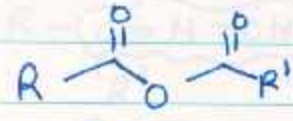
11] :→ Peroxide

12] :→ Acetal

13] :→ Ketal

19] :→ Ortho Ester

15] :→ Carbonate Ester

16]  / $R-COOCOR'$:→ Acid anhydride

• :→ Phenol

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Sulphur containing F.G.

17] $R-SH$:→ Thiol

18] $R-S-R'$:→ Thio ether

19] $R-S-S-R'$:→ Disulphide

20] $R-C(=S)-H$:→ Thial

21] $R-C(=S)-R'$:→ Thione

22] $R-C(=O)-S-R'$:→ Thioester

23] $R-S(=O)(=O)-OH$:→ Sulphonic acid ($R-SO_3H$)

24] $R-S(=O)(=O)-O-R'$:→ Sulphonic Ester ($R-SO_3R'$)

25] $R-SO_2H$:→ Sulphinic acid

26] $R-SO_2R'$:→ Sulphinic Ester

27] $R-S(=O)-R'$:→ Sulphonide

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Nitrogen containing F.G.

28] $R-NH_2$; $R-NH-R'$; $R-\underset{\underset{R''}{|}}{N}-R'$; $R-\overset{\overset{R'''}{|}}{\underset{\underset{R''}{|}}{N^+}}-R'$

Amines

29] $R-C\equiv N$ / $R-CN$:→ Cyanide

30] $R-N^+\equiv C^-$ / $R-NC$:→ Isocyanide

31] $R-N=C=O$:→ Isocynate

32] $R-\underset{\underset{O}{\|}}{N^+-O^-}$:→ Nitro

33] $R-O-N=O$:→ Nitrite

34] $R-NO$ / $R-\underset{\underset{O}{\|}}{N}$:→ Nitroso

35] $R-\underset{\underset{R'}{|}}{C=N}-R'$:→ Imide

36] $R-\underset{\underset{R'}{|}}{C=N-OH}$:→ Oxime

37] $R-\overset{\overset{O}{\|}}{C}-N\begin{matrix}R_1\\R_2\end{matrix}$:→ Acid Amide

$R-CONR_1R_2$

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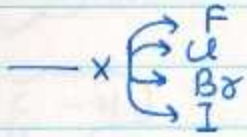
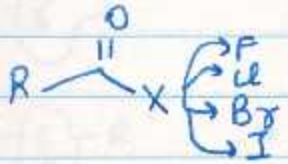
38] :→ Imide

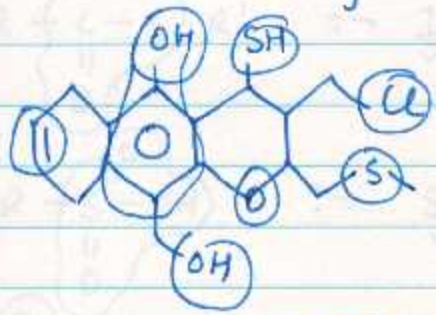
39] $R-N=N-R'$:→ Azo

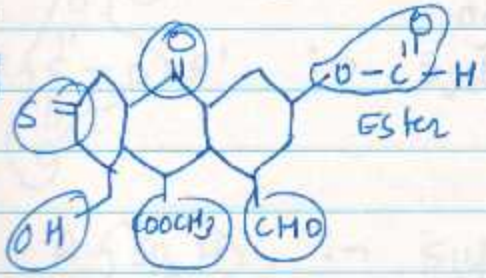
40] $R-N_3$:→ Azide ($R-\overset{\ominus}{N}-\overset{\oplus}{N}\equiv N$).

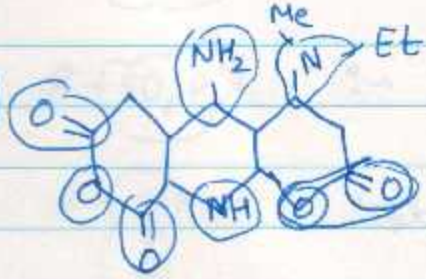
41]  :→ (Halides)

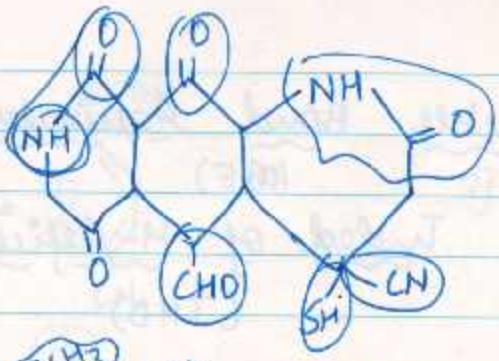
42]  :→ Acid Halides

Q. Calculate no. of F.G. (types)

1]  (7)

2]  (6)

3]  (5)

4] 

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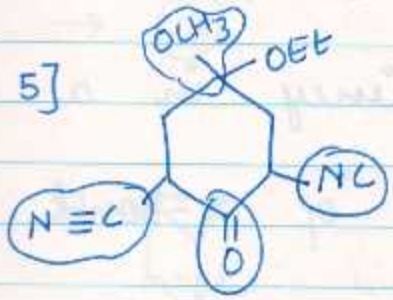
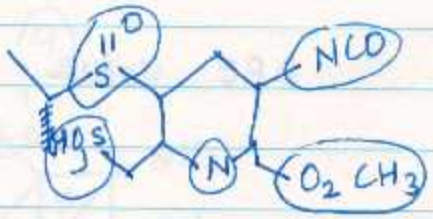
5] 

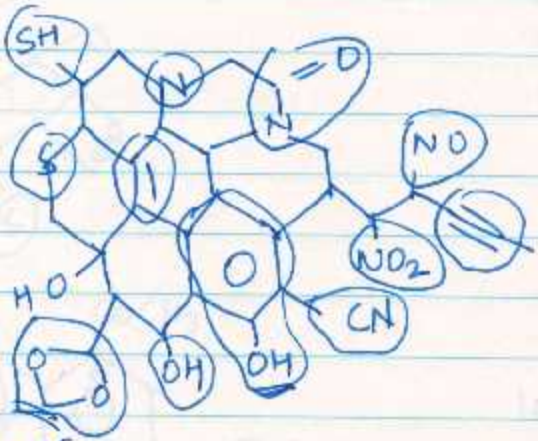
4

6] 

5

7]

4

8] 

Cyclic Acetal

12

* Degree of Unsaturation / Double Bond Equivalent / Index of H-deficiency
(DU) (DBE) (IHD)

- It tells us abt. amt. of H-deficiency in a compound.
- Deficiency occurs due to presence of π-bond or a ring / loop.

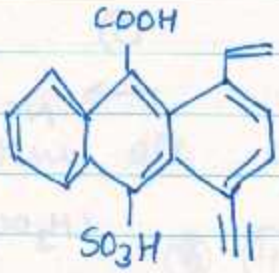
Structure	Molecular Formula	DBE Value
→ saturated	C_5H_{12}	0
	C_5H_{10}	1
	C_5H_8	2
	C_5H_6	3

- Each π-bond & ring contributes '1' to DBE value.

Q.

1]

→ (7)

2] 

→ (16)

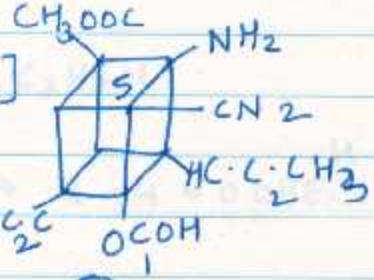
3]

→ (4)

4]

(n-1)

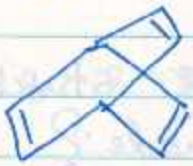
→ (5)

5] 

→ (13)

6]

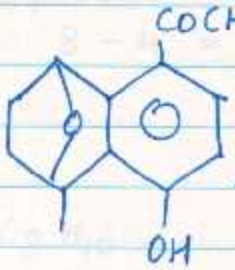
→ (2)

7] 

→ (5)

8]

→ (2)

9] 

→ (7)

10] $HCOO^-$

→ (1.5)

11]

→ (6.5)

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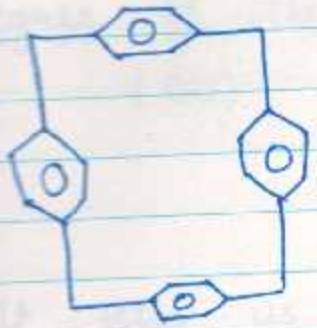
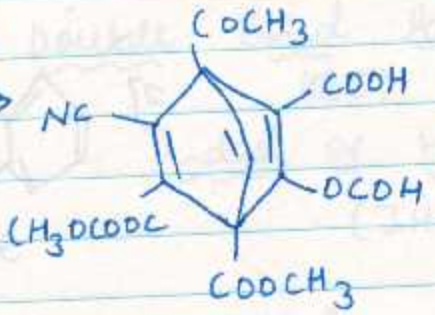
12]



→ (A)

13)



→ (B)

- DBE calculation using Molecular Formula :→

Let us take a compound having molecular formula,

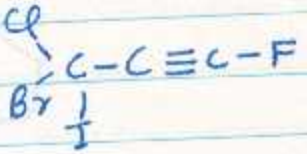
$C_x H_y N_z O_w X_\phi \cdots$

$$D.B.E. = (C+1) - \left(\frac{H+X-N}{2}\right)$$

C : no. of C, H : no. of H, N : no. of N, X : no. of Halogens

1] $C_3FClBrI$

→ $(4) - \left(\frac{4}{2}\right) = 2$. Here how many diff. structures of Alkynes can be made?



(4).

2] $C_4H_6Cl_2$

→ $5 - 4 = 1$ how many cyclic structures are possible? (only 4 membered)

(2)

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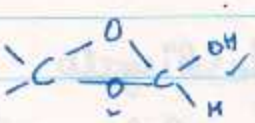
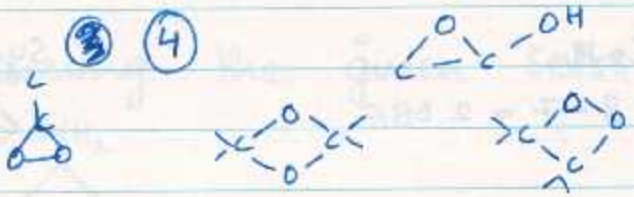
3] $C_2H_4O_2$

$\longrightarrow$ 3 − 2 = 1. Form all cyclic structures.



(3) (4)



4] $C_5H_{13}N$

$\longrightarrow$ 6 − 6 = 0 DBE

5] C_3H_9N

$\longrightarrow$ 4 − 4 = 0 DBE

6] $C_9H_{16}NOCl$

$\longrightarrow$ 10 − 8 = 2 DBE

7] $C_2F_2Cl_2$

$\longrightarrow$ 2 − 2 = 0 DBE

8] $C_2FClBrI$

$\longrightarrow$ 2 − 2 = 1 DBE

All Alkenes.

(3)

9] C_7H_8

$\longrightarrow$ 8 − 4 = 4 DBE

Containing Benzyne

(1)

10] C_8H_{10}

$\longrightarrow$ 9 − 5 = 4 DBE

Containing Benzyne

(3)

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11] C_4H_6

→ 5 − 3 = 2 DBE

Bicyclo.

①

12] C_8H_{14}

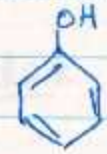
→ 9 − 7 = 2 DBE

Symmetrical Bicyclo.

13] C_7H_8O

→ 8 − 4 = 4 DBE

Phenol



③

* Homologous series :→

Alkane : CH_4, C_2H_6, C_3H_8 .... C_nH_{2n+2}

Alkene : C_2H_4, C_3H_6, C_4H_8 .... C_nH_{2n}

Alkyne : C_2H_2, C_3H_4, C_4H_6 ..... C_nH_{2n-2}

Alcohol : CH_4O, C_2H_6O, C_3H_8O .... $C_nH_{2n+2}O$

Properties of Homologous series,

1) They have same functional group
2) They have same general formula
3) have same value of DBE
4) Each successive homologue differ by CH_2 unit and 14 units of mass.
5) They have similar chemical properties. i.e. they

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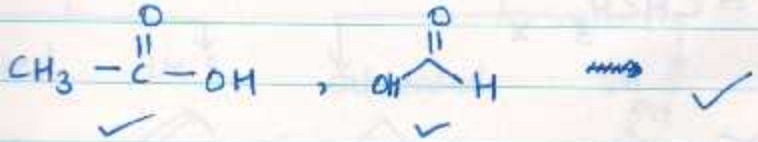
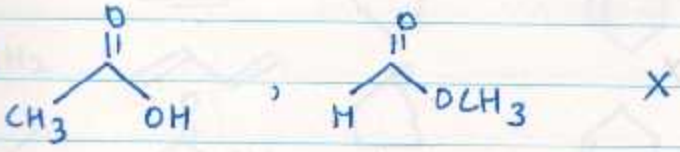
show similar type of reactions.

6) They show a particular trend in physical properties.

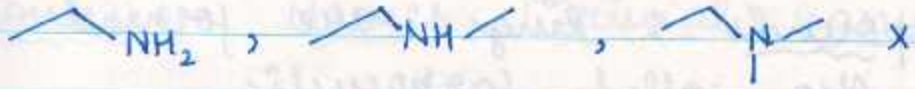
9. Identify homologues among the given sets.

1] ✓ ✓ ×

2]  ✓ ✓ ✓

3]  ×

4] ×

5]  ×

6] ✓

7] ✓

8] ×

9] $CH_2 = CH_2$, $CH_2 = C = CH_2$ ×

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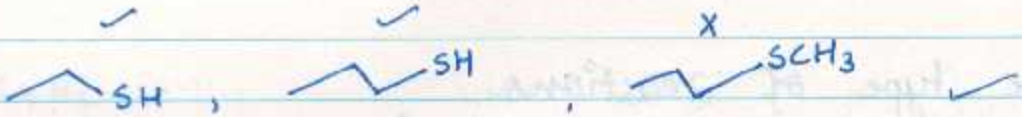
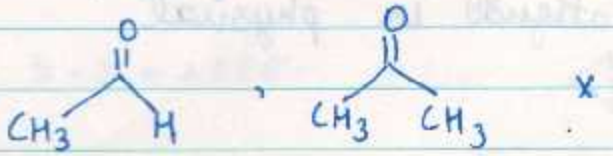
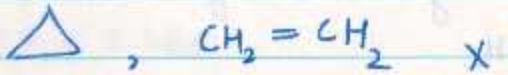
10]  ✓ ✓ X

11]  X

12]  X

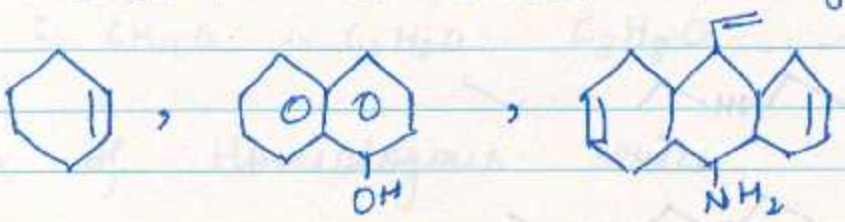
13] $CH_3 - C \equiv CH$, $CH_2 = C = CHCH_3$ X

14] ✓

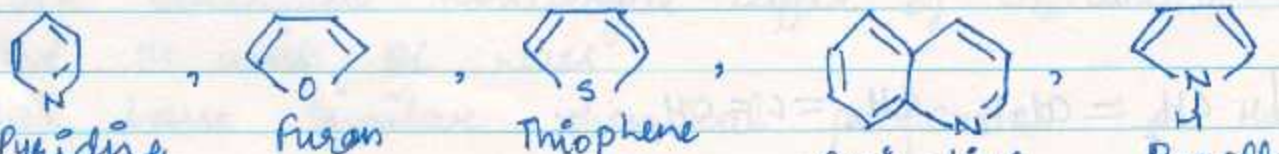
15] X

16] X

- Homocyclic compounds : Rings are formed only using carbon. Also called carbocyclic.

Eg: 

- Heterocyclic compounds : Rings contain atleast one other atom (than C)

Eg: 

Pyridine, Furan, Thiophene, Pyrrole

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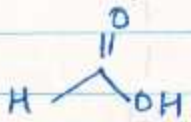
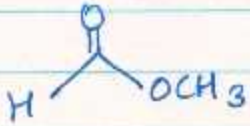
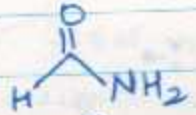
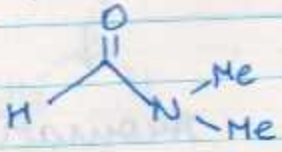
* Classification of Organic Compounds :→

- Aliphatic
  - Open chain (acyclic)
    - Saturated
    - Un-S.
  - Closed Chain (alicylic)
    - Saturated
    - Un-S.
- Aromatic
  - Homocyclic
    - (conjugation)
    - (Napthelene)
    - (Anthracene)
  - Heterocyc
    - (Furan)
    - (Pyridine
    - (Thiophen

* Common Names (Trivial name) :→

These names are based on the origin of the compound or it may be historical reason

-  → Formic acid
- → Formaldehyde
-  → Methyl Formate

-  → Formamide
-  → N, N - Dimethyl Formamide (DMF)
- $CH_3-\overset{O}{\overset{\|}{C}}-OH$ → Acetic Acid
- $CH_3-\overset{O}{\overset{\|}{C}}-H$ → Acetaldehyde
- $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ → Acetone
- CH_3-CH_2-COOH → Propionic acid

* IUPAC Naming :→

- Why it is needed ?

→ As there are lakhs of compounds some standard rules were needed to name them and these rules were summarized by IUPAC.

- General scheme of IUPAC naming :→

$\underbrace{\text{Mr.}}_{\text{Prefix}}$ $\underbrace{\text{Chunnu}}_{\text{Word Root}}$ $\underbrace{\text{Lal}}_{\text{Suffix}}$

⇒ Prefix Word Root Suffix

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- Word Root : It tells us about number of carbon in the parent chain (Principal chain)

No. of Carbon	Word Root
1	Meth
2	Eth
3	Prop
4	But
5	Pent
6	Hex
7	Hept
8	Oct
9	Non
10	Dec
11	Undec
12	Dodec
13	Tridec
⋮	⋮
20	Eicos
⋮	⋮
30	Triacont
⋮	⋮
100	Hect
⋮	⋮
123	Trieicoshect

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- 1° Suffix : It tells us about presence of saturation / unsaturation in a compound.

→ Propane
W.R. 1°S

→ Propene
W.R. 1°S

→ Propyne
W.R. 1°S

- 2° Suffix : It tells us about principal functional group in a given compound.

→ Ethanol
Eth + ane + ol
WR 1°S 2°S

a, e, i, o, u, y

→ Propanamine
WR 1°S 2°S

→ Butanal
WR 1°S 2°S

- 1° Prefix : It tells us whether parent chain is cyclic or not.

→ Cyclopropane
1°P WR 1°S

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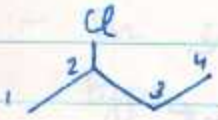
→ Cyclobutanol
1°P WR 1°S 2°S

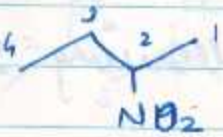
→ Cyclohexanamine
1°P WR 1°S 2°S

- 2° Prefix : It tells us about locants present in the parent chain. Few functional are always treated as locants.

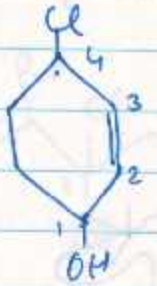
Eg: $-F, -Cl, -Br, -I$ ⇒ Fluoro, Chloro, Bromo, Iodo
$-NO_2, -NO, -ONO$ ⇒ Nitro, Nitroso, Nitrito
$-OR$ ⇒ Alkoxy
- Junior f. gp.



→ 2-Chloro butane
2°P



→ 2-Nitro butane
2°P

Q. 

→ 4-Chloro cyclohex-2-enol
2°P 1°P WR 1°S 2°S

- Rules :→

a) How to select the principal chain ? (In Alkanes)

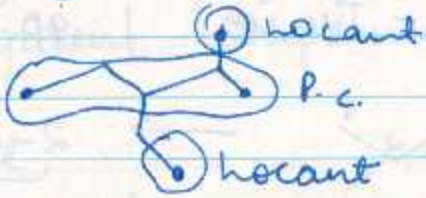
- Select the longest chain having maximum ~~no. of locants~~.
- If multiple chains have same C-atoms then select the one having more no. of locants.

Eg : •

•

•

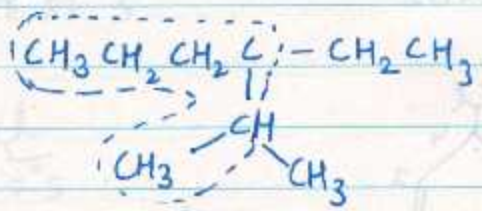
•



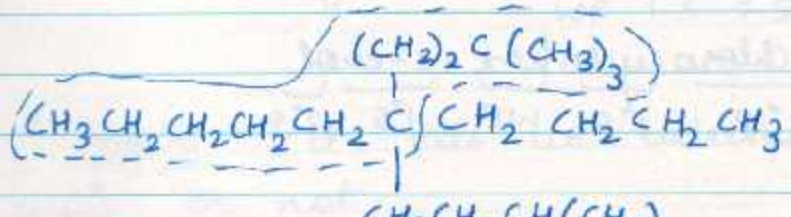
Q. Select the principal chain among following :

a)

b)

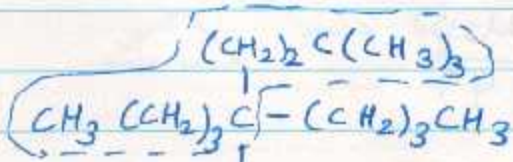


c)



e)

d)



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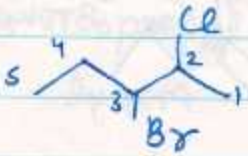
b) Numbering :→

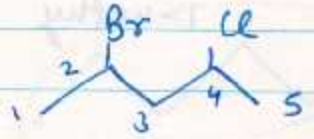
- It is done from the corners.
- It is done in such a way that locant receives lowest number (lowest locant rule)

2-chloropentane

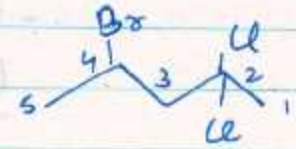


3-Bromo-2-chloropentane

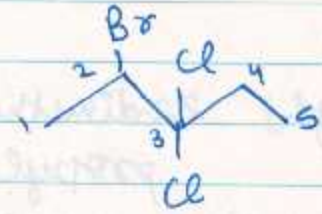
- If numbering is same from both sides use alphabetical order
- Write the locants in alphabetical order
- In case of multiple locants of same type you should use di, tri, tetra, etc. (do not consides these prefixes in A.O.)



2-Bromo-4-chloropentane



4-Bromo-2,2-dichloro pentane



2-Bromo-3,3-dichloropentane

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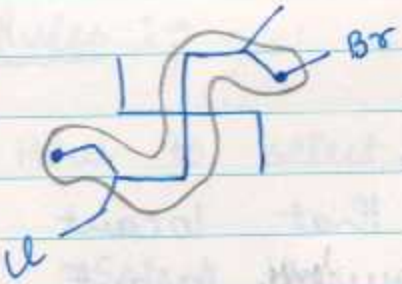
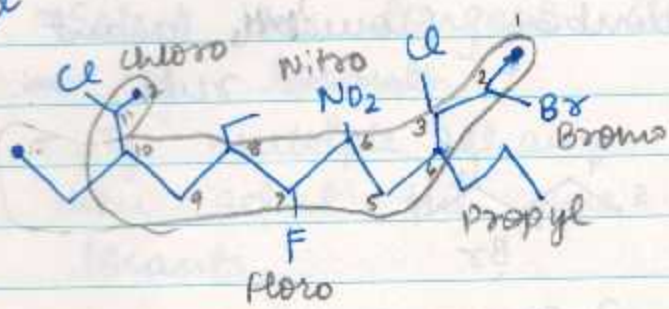
Q.

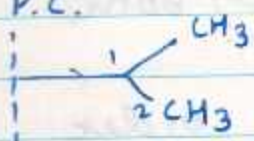
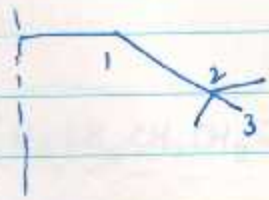
1) 

⇒ 1-Bromo-6-chloromethyl-4,4-diethyl-2-methyl octane.

2) 

⇒ 2-Bromo-3-chloro-~~10~~, 4-propyl ~~chloroethyl~~ -7-flouro-6-Nitrose, Dodecane

Complex substituents

P.C.		Common Name	IUPAC
	-Iso	Isopropyl	1-methyl ethyl
	-Iso	Isobutyl	2-methyl propyl
	-secondary (-sec)	sec. butyl	1-methy proph
	-Tertiary -tert./-t	-t butyl	1,1-dimethy ethyl
	-Neo	-Neopentyl	2,2-dimethyl propyl

- consider iso, neo in alphabetical order. Also consider di, tri present in the complex substituents.
- In case, complex sub. appears multiple times then use di, tri when common name is used and Bis, tris,

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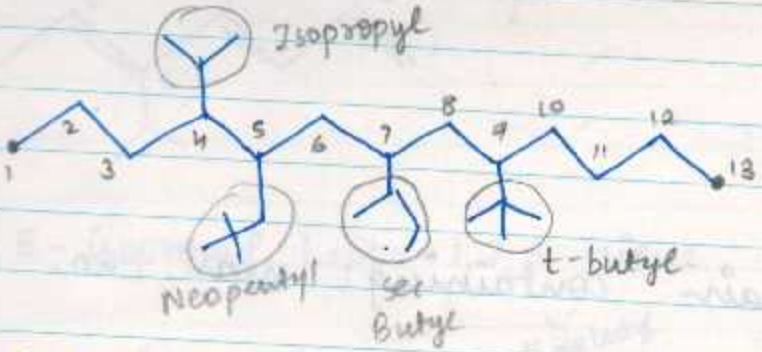
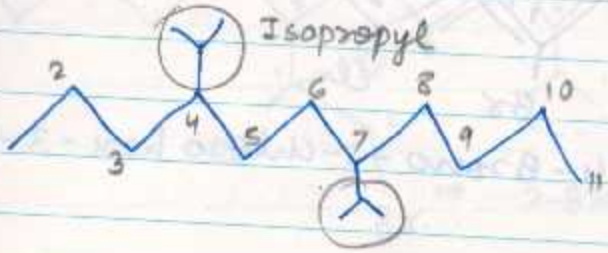
Q.

1)



⇒ 7-Sec.butyl-9-(t-butyl)-4-Isopropyl-5-Neopentyl TriDeca

2)

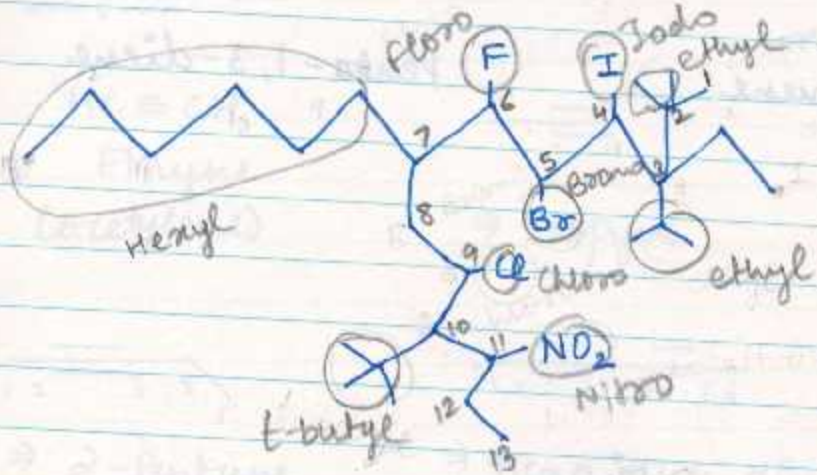


⇒ 4,7-diisopropyl undecane

OR

4,7-bis(1-methyl ethyl) undecane

*3)



5-Bromo-10-(t-butyl)-9-Chloro-2,3-diethyl-6-Floro-7-Hexyl-4-Iodo-11-Nitro tridecane

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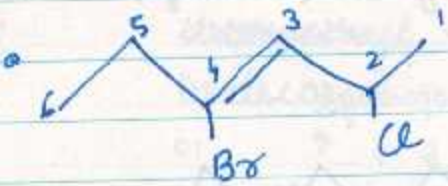
* Naming of Alkenes

- Select the longest chain containing max. no. of Alkenes.

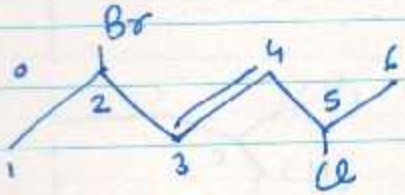
4-Bromo pent-2-ene

OR

4-Bromo-2-pentene

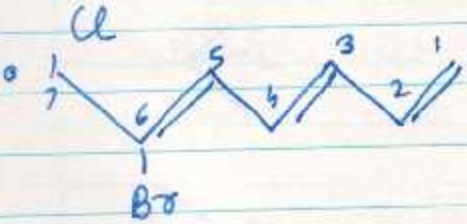


4-Bromo-2-chloro hex-3-ene



2-Bromo-5-chloro-3-hexene

Penta-1,3-diene



6-Bromo-7-chloro-1,3,5-Heptatriene

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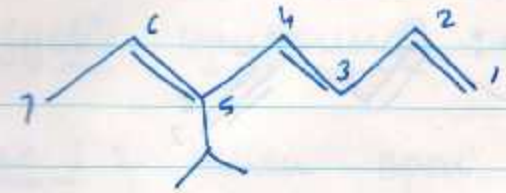
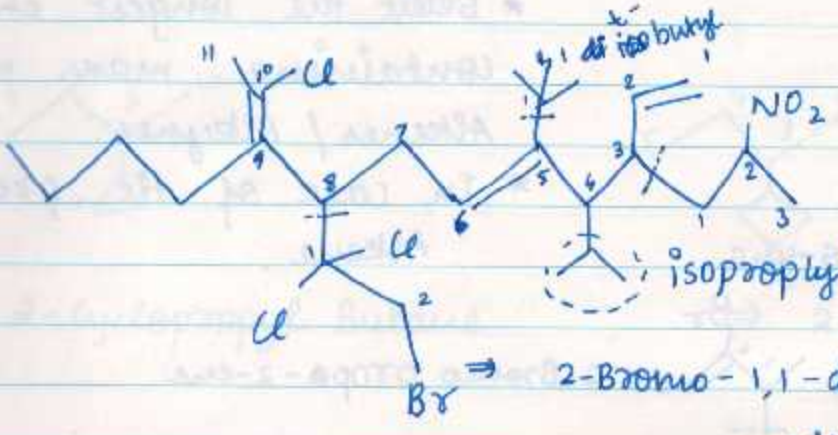
Q.



⇒ 5-isopropyl hepta-1,3,5-triene.

Q.



⇒ 2-Bromo-1,1-dichloro ethayle

2-Nitro propayle

⇒ 8-(2-Bromo-1,1-dichloro ethyl)-10-chloro-5-isobutyl-4-isopropyl-3(-2-Nitro propyl) Undeca-1,5,9-triene

* Alkynes :→

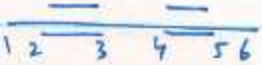
$HC \equiv CH$

⇒ Ethyne (Acetylene)

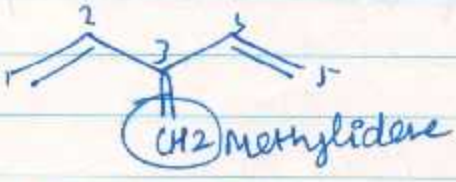
⇒ Propyne

⇒ 2-Butyne

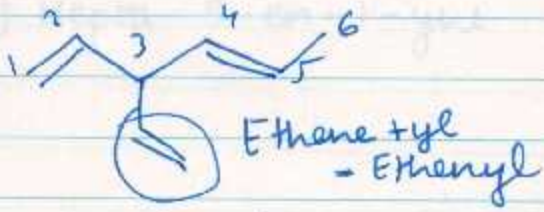
⇒ 2-Pentyne



⇒ Hexa-2,4-diyne



⇒ 3-methylidene penta-1,4-diene



⇒ 3-Ethenyl Hexa-1,4,-diene

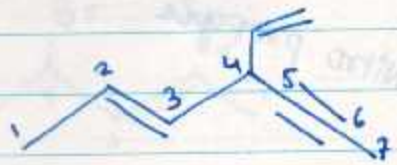
Q. a)

⇒ Hex-5-en-1-yne

b)

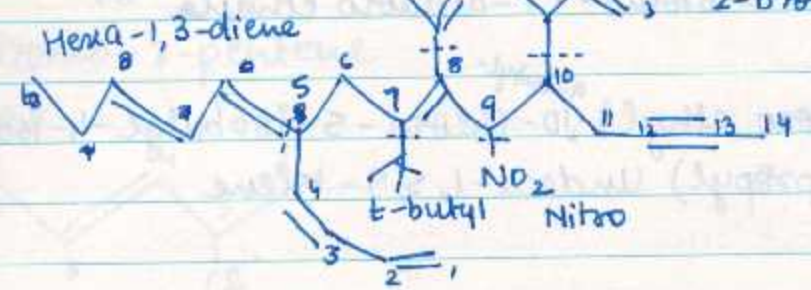
⇒ Hept-2-en-5-yne

* Select the longest chain containing max. no. of Alkenes / Alkynes.
* In case of tie, prefer Alkene.

c) 

⇒ 4-Ethenyl Hept-2-en-5-yne

2-Bromo prop-2-ene

d) 

⇒ 10-(2-Bromo prop-2-ene)-7-(t-butyl)-

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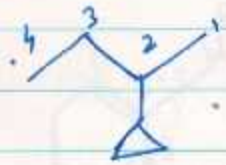
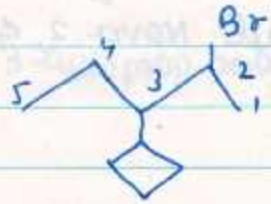
* Cyclic compounds :→

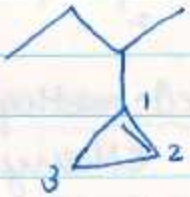
Case I : When open chain contains more carbon in parent chain than the cyclic. 'C' of Cyclo will be used / considered in A.D.



⇒ 2-Cyclopropyl Butane

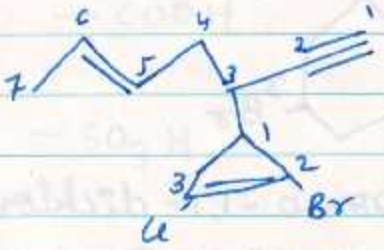


⇒ 2-Bromo-3-cyclobutyl Pentane

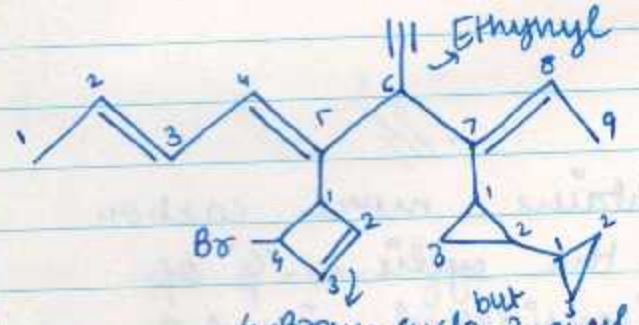


⇒ 1-sec. butyl cyclopropene

⇒ 3-(1-ethyl propyl) cyclopropene



⇒ 3-(2-Bromo-3-chloro-prop-2enyl) Hepta-5-en-1-yne



2-Cyclopropyl cyclo propyl

4-Bromo cyclo but-2-enyl

⇒ 5-(4-Bromo cyclobut-2-enyl)-7-(2-cyclopropyl cyclopropyl)-6-Ethynyl Nona-2,5,7-triene

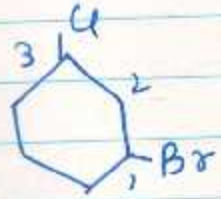
Case - II

⇒ Propyl cyclopropane

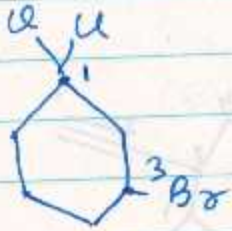
⇒ Isopropyl cyclopropane

⇒ 3-(1-methyl ethenyl cyclopropane)

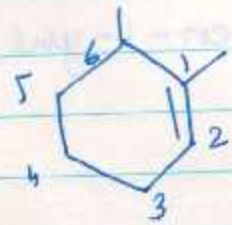
Case - III



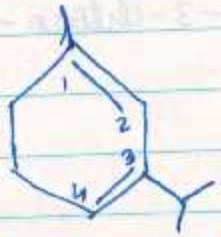
⇒ 1-Bromo-3-Chloro Cyclohexane



⇒ 3-Bromo-1,1-dichloro cyclohexane



⇒ 1,6-dimethyl cyclohexene



⇒ 3-Isopropyl-1-methyl-hexa-1,3-diene

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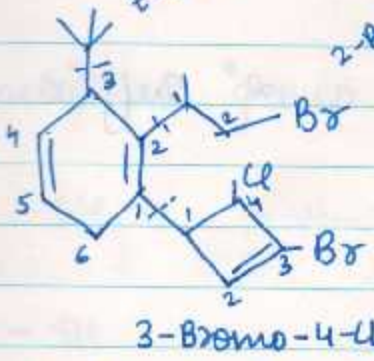
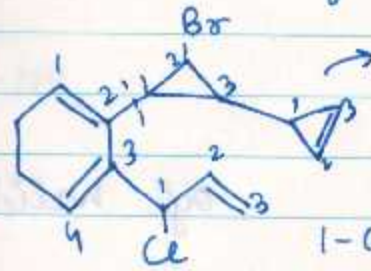
Q. 

3-Bromo-4-chloro cyclobut-2-enyl

⇒ 1-(3-Bromo-4-chloro cyclobut-2-enyl) - 2(2-Bromo-1-Methyl ethyl) - 3 - t-butyl - Hexa-1,4-diene

Q. 

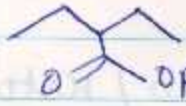
→ 2-Bromo-3-cycloprop-2enyl cyclopropyl

1-chloro prop-2-enyl

⇒ 2-(2-Bromo-3-cycloprop-2-enyl cyclopropyl) 3-(1-chloro prop-2-enyl)Hexa-1,3-diene

* Nomenclature of Functional group :→

Priority Table

	Functional group	2° Prefix	2° suffix
1.	$-COOH$	carboxy	oic acid
2.	$-SO_3H$	sulpho	Sulphonic acid
3.	$-\overset{\overset{O}{\|\|}}{C}-O-\overset{\overset{O}{\|\|}}{C}-$	—	anhydride
4.	$-\overset{\overset{O}{\|\|}}{C}-O-$	i) 	oate

alkoxy carbonyl

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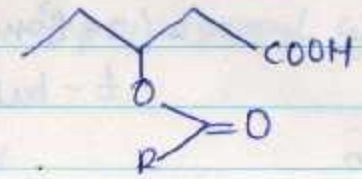
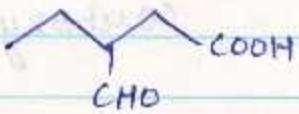
Functional group	2° Prefix	2° Suffix
	ii)  alkanoyl oxy if R = $-CH_3$ (ethanoyl oxy).	
5. $-\overset{\overset{O}{\|}}{C}-X$	halo carbonyl	oyl halide
6. $-\overset{\overset{O}{\|}}{C}-NH_2$	carbanoyl or carboxamido	amide
7. $-C\equiv N$	cyano	nitrile
8. $-\overset{+}{N}\equiv C^-$	isocyano	isonitrile
9. $-\overset{\overset{O}{\|}}{C}-H$	(i)  formyl	al
	ii) oxo	
10. $-\overset{\overset{O}{\|}}{C}-$	oxo / keto	one

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Functional group	2° prefix	2° suffix
11. $-OH$	hydroxy	ol
12. $-SH$	mercapto or sulfanyl	thiol
13. $-NH_2$	amino	amine

i) $-NH-Me$

N-methyl amino

ii) $-N(Et)(Me)$

N-ethyl-N-methyl amino

* Rules :→

#1 : Priority in parent chain selection

Main F. Gr. > Multiple bond > no. of C atoms in a chain

#2 : Priority in numbering

Main F. Gr > M. B. > Substituent

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- Notes

- The last alphabet 'e' of the 1° suffix is removed if the 2° suffix begins with a vowel.

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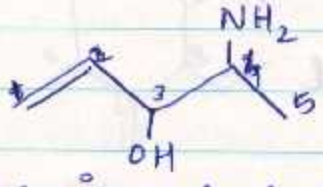
Q. IUPAC Names

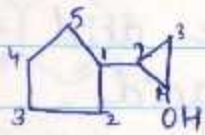
1.

⇒ Pent-4-en-2-ol

2. 

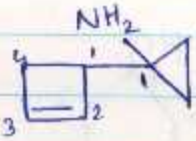
4-amino pent-1-en-3-ol ✓

⇒ 3-hydroxy pent-4-en-2-amine ✗

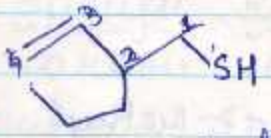
3. 

⇒ 1-(2-cyclopropanol) cyclopentane ✗

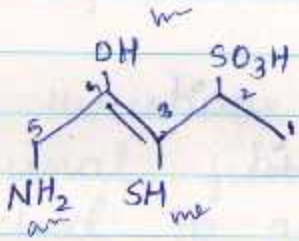
2-cyclopentyl cyclopropanol ✓

4. 

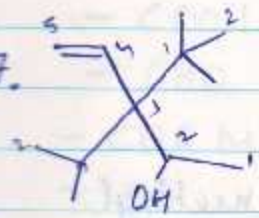
⇒ 1-(cyclobut-2-enyl) cyclo propanamine

5. 

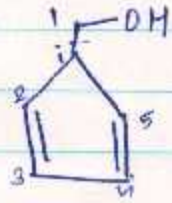
⇒ 2-propyl ~~pent~~ but-3-ene-1-thiol

6. 

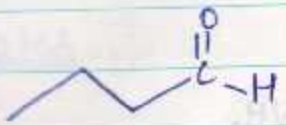
⇒ 5-amino-4-hydroxy-3-mercapto pent-3-ene-2-sulphonic acid

7. 

⇒ 3-[1,1-dimethyl ethyl]-3-[1-methyl ethyl] pent-4-en-2-ol

8. 

⇒ 1-(cyclopenta-2,4-dienyl) methanol

1. 

⇒ Butanal

10. $CH_3 - CHO$

⇒ Ethanal
(Acetaldehyde) - common name

11.

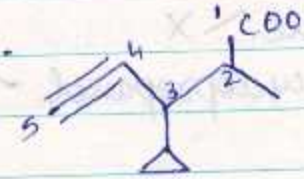
⇒ Propan-2-one
⇒ Propanone
(Acetone) - common name

12. $HCOOH$

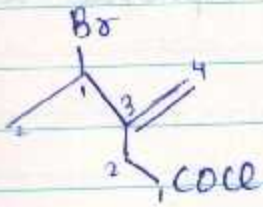
⇒ IN: Methanoic acid
CN: Formic acid

13. CH_3COOH

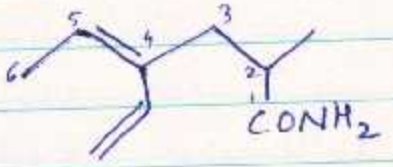
⇒ IN: Ethanoic acid
CN: Acetic acid

14. 

⇒ 3-cyclopropyl-2-methyl pent-4-enoic acid

15. 

⇒ 3-(Bromo ethyl) but-3-en-1-oyl chloride

16. 

⇒ 4-Ethenyl-2-methyl hex-4-en-1-amide

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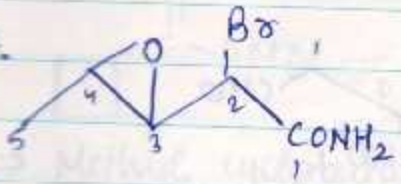
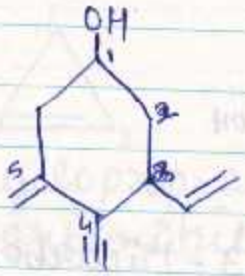
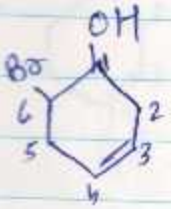
17. 

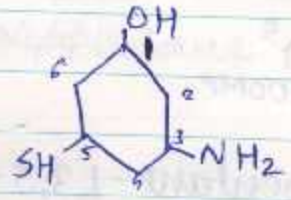
⇒ 2-Bromo-3,4-epoxy pentanamide

18. 

⇒ 3-Ethenyl-4-Ethynyl-5-methylidene cyclohexanol

19. 

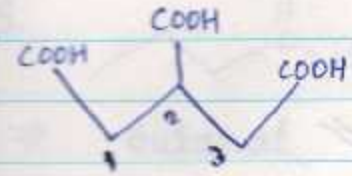
⇒ 6-Bromo cyclo hex-3-enol

20. 

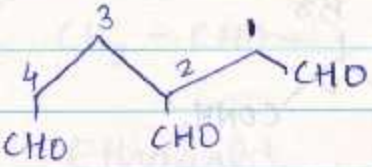
⇒ 3-amino-5-mercapto cyclohexanol.

* Specific Rule (1993) : If three or more same carbon containing terminal functional groups are directly attached to an unbranched alkane then alkane is considered the parent chain and the following suffixes are used,

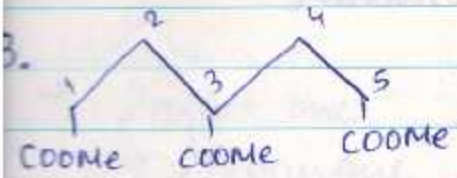
$-COOH$	carboxylic acid
$-CHO$	carbaldehyde
$-COOMe$	carboxylate
$-CN$	carbonitrile
$-COX$	carbonyl halide
$-CONH_2$	carbonamide

1. 

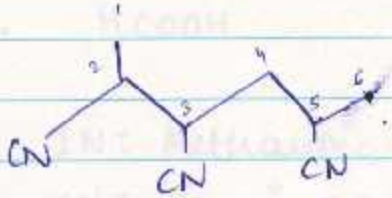
⇒ propane-1,2,3-tricarboxylic acid

2. 

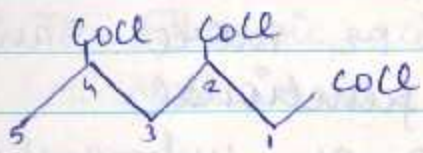
⇒ Butane-1,2,4-tri carbaldehyde

3. 

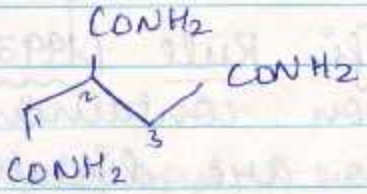
⇒ trimethyl pentane-1,3,5-tricarboxylate

4. 

⇒ Hexane-2,3,5-tricarbonitrile

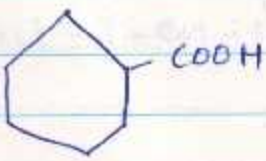
5. 

⇒ Pentane-1,2,4-tricarbonyl chloride

6. 

⇒ Propane-1,2,3-tricarbon amide

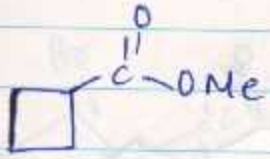
Note: If carbon containing terminal F.G. is directly attached to ring then also the above suffixes are used.

1. 

⇒ Cyclohexane carbonylic acid

2.

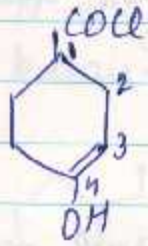
⇒ 2-Bromocyclopentane carbaldehyde

3. 

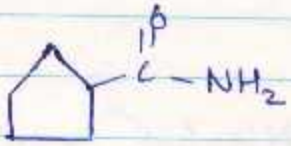
⇒ Methyl cyclobutane carbonylate

4.

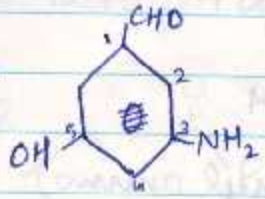
⇒ Cyclopрop-2-ene carbonitrile

5. 

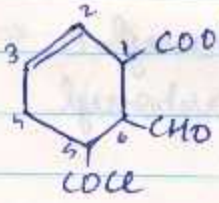
⇒ 4-hydroxy cyclo hex-3-ene carbonyl chloride

6. 

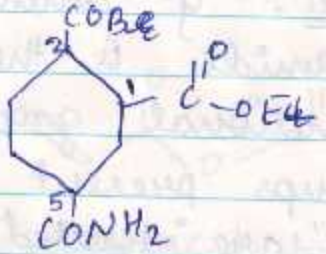
⇒ Cyclopentane carboxamide

7. 

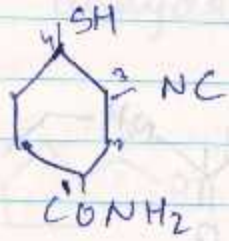
⇒ 3-amino-5-hydroxy cyclo ~~pentane~~ Hexa carbaldehyde

8. 

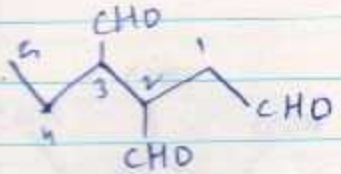
⇒ 6-Formyl-5-~~Hydro~~ chloro carbonyl cyclo hex-2-ene carbonylic acid

9. 

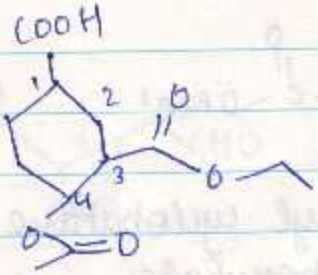
⇒ Ethyl-2-Bromo carbonyl-5-carbamoyl cyclo hexane carboxylate

10. 

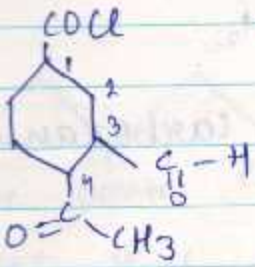
⇒ 3-isocyano-4-mercapto cyclo hexane carboxamide

11. 

⇒ Pentane-1,2,3-tricarbaldehyde

12. 

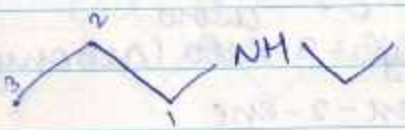
⇒ 4-ethanoyl oxy-3-ethoxy carbonyl cyclohexane carboxylic acid.

13. 

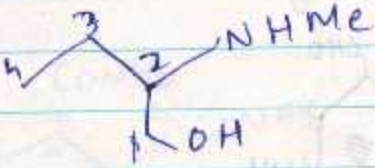
⇒ 4-acetyl-3-formyl cyclohexane carbonyl chloride

14.

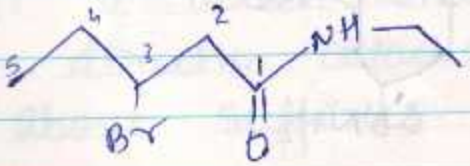
⇒ N-ethyl-N-methyl pentan-2-amine

15. 

⇒ N-ethyl propan-1-amine

16. 

⇒ 2-(N-methyl amino) butanol

17. 

⇒ 3-Bromo-N-(N-ethyl) pentan-1-amide

Note: If amine or amide is the main functional group then groups present on 'N' are treated as substituents present at 'N' locant on the main parent chain. ('N' is not considered in alphabetical order).

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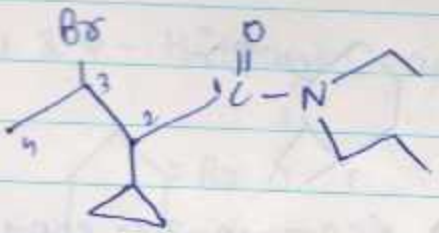
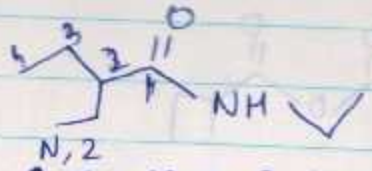
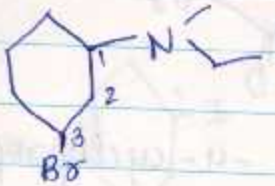
18. 

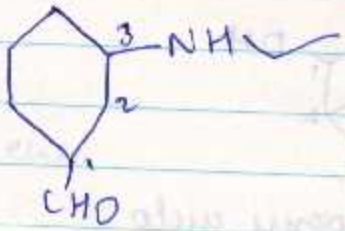
⇒ 3-Bromo-2-cyclopropyl-N-ethyl-N-propyl butan-1-amide

19. 

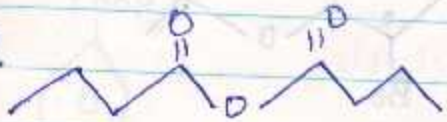
⇒ 2,N-diethyl butan-1-ami

20. 

⇒ 3-Bromo-N-ethyl-N-methyl cyclohexan-1-amine

21. 

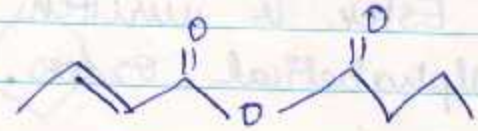
⇒ 3-(N-ethyl amino) cyclo hexane carbaldehyde

22. 

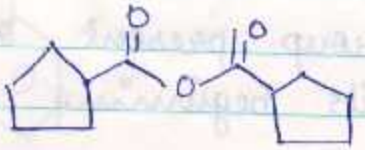
⇒ Butanoic anhydride (named after acid from which it is formed)

23.

⇒ Ethanoic propanoic anhydride

24. 

⇒ Butanoic but-2-enoic anhydride

25. 

⇒ cyclopentane caronylic anhydride

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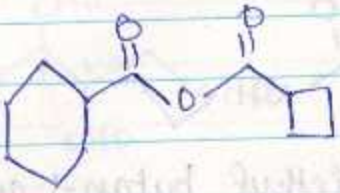
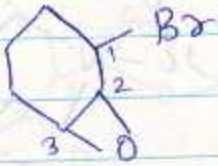
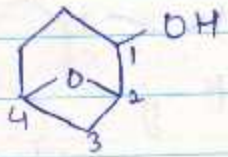
26. 

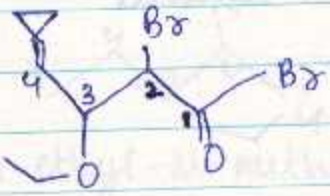
⇒ Cyclobutane carbonylic cyclohexane carbonylic anhydride

27. 

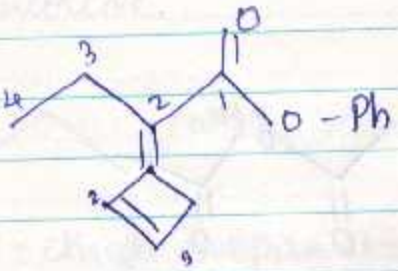
⇒ 1-Bromo-2,3-epoxy cyclohexane

28. 

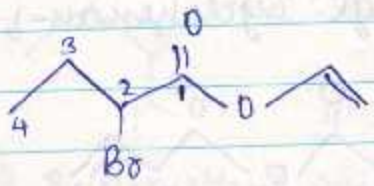
⇒ 2,4-epoxy cyclo hexanol

29. 

⇒ 2-Bromo-4-cyclopropylidene, 3-ethoxy butanoyl bromide

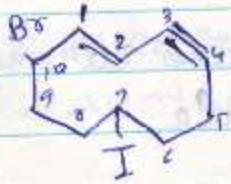
30. 

⇒ Phenyl 2-(cyclobut-2-enylidene) Butanoate

31. 

⇒ Ethenyl 2-Bromo Butanoate

Note: Group present on oxygen of Ester is written at its beginning irrespective alphabetical order.

32. 

⇒ 10-Bromo-7-Iodo cyclodec-1-en-3-yne

33. Write the correct IUPAC name of the following :→

a) 2-ethyl butane
⇒ 3-methyl propane

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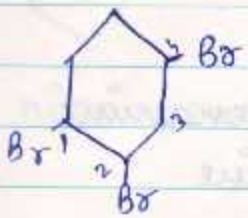
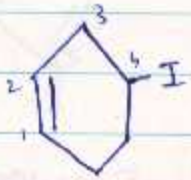
b) 1, 3, 4 - tribromo cyclohexane



⇒ 1, 2, 4 - tribromo cyclohexane

c) 2-iodo cyclohex-5-ene



⇒ 4-iodo cyclohex-1-ene

* Nomenclature of Benzene Derivatives :→

1.

⇒ IN: Benzene carboxylic acid
CN: benzoic acid

2.

⇒ IN: Benzene carbaldehyd
CN: benzyaldehyde

3.

⇒ IN: Benzene carbonamid
CN: benzamide

4.

⇒ IN: benzene carbonyl chlori
CN: benzoyl chloride

5.

⇒ IN: Benzene carbonitrile
CN: benzonitrile

6.

⇒ IN: Ethyl benzene carbonyl
CN: ethyl benzoate

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7.

⇒ IN: benzenol
CN: Phenol, carbolic acid

8.

⇒ IN: benzenamine
CN: Aniline

9.

⇒ IN: methyl benzene
CN: Toluene

Note: • The common names for the above compounds are also accepted by IUPAC
• These can also serve as parent chain.

10.

⇒ IN: Methoxy benzene
CN: Anisole

11.

⇒ IN: ethoxy benzene
CN: Phenetole

12.

⇒ Benzene sulphonic acid

13.

⇒ benzene thiol

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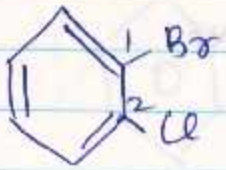
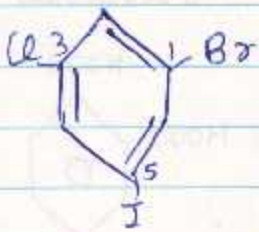
14.

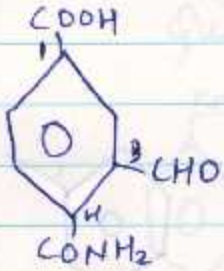
⇒ nitro benzene

15. 

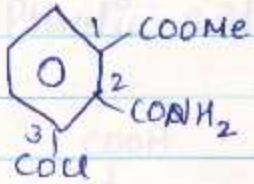
⇒ 1-Bromo-2-chloro benzene

16. 

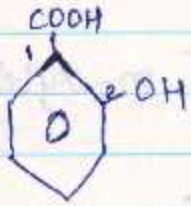
⇒ 1-bromo-3-chloro-5-iodo benzene

17. 

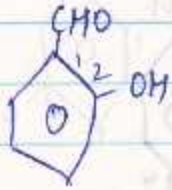
⇒ 4-carbonoyl-3-formyl benzene cabonylic acid

18. 

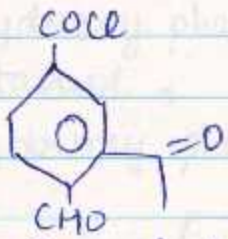
⇒ Methyl 2-carbanoyl-3-chloro carbonyl benzanoate

19. 

⇒ 2-hydroxy benzoic acid (CN: Saliylic acid)

20. 

⇒ IN: 2-hydroxy benzaldehyde
CN: Salicylaldehyde

21. 

⇒ 3-acetyl-4-formyl benzoyl chloride

(Acetyl = $-\overset{O}{\overset{\|}{C}}-CH_3$)

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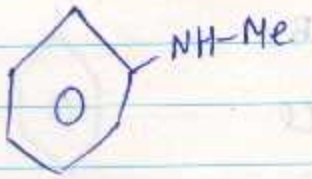
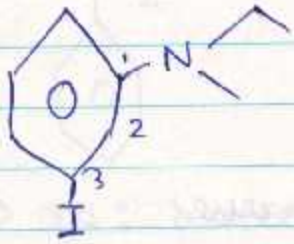
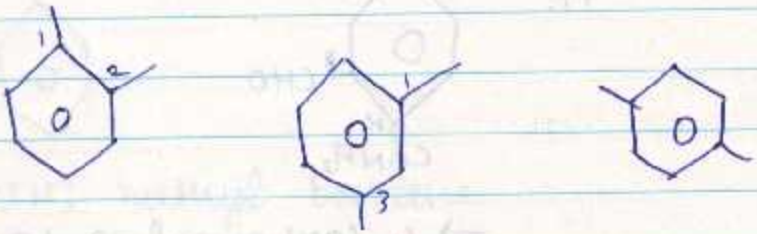
22. 

⇒ N-methyl aniline

23. 

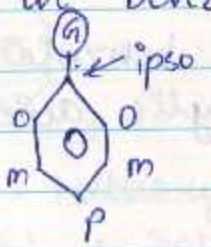
⇒ N-ethyl-3-Iodo-N-methyl aniline

24. 

IN: 1,2 dimethyl benzene | 1,3 dimethyl benzene | 1,4-dimethyl benzene

CN: O-xylene | m-xylene | P-xylene

Note: In benzene,



ortho - (o) - [1,2]
meta - (m) - [1,3]
para (p) - [1,4]

25.

IN: 2-methyl phenol | 3-methyl phenol | 4-methyl phenol

CN: O-cresol | m-cresol | p-cresol

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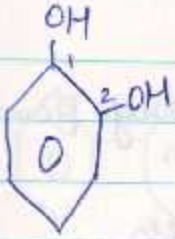
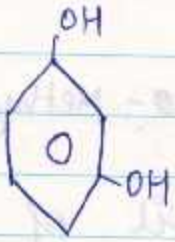
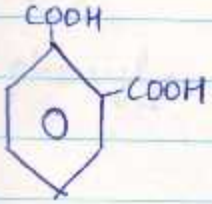
26.  

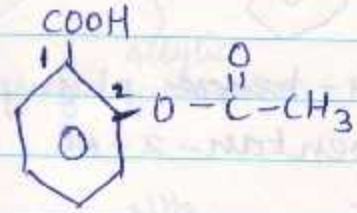
IN: benzene-1,2-diol benzene-1,3-diol benzene-1,4-diol

CN: Catechol Resorcinol Quinol

27. 

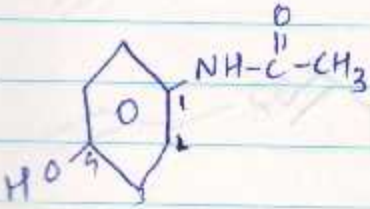
IN: benzene-1,2-dicarbonylic acid benzene-1,3-dicarbonylic acid benzene-1,4-dicarbonylic acid

CN: Phthalic acid Iso Phthalic acid Tere Phthalic acid

28. 

IN: 2-Ethanoyl oxy benzoic acid

CN: Aspirin

29. 

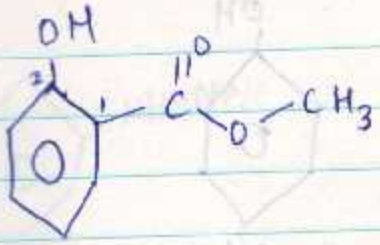
IN: N-[4-hydroxy phenyl] ethanamide

CN: Paracetamol,
N-[4-hydroxy phenyl] acetamide

Note: Phenyl (Ph) =
or
Aryl (Ar)
or
C_6H_5

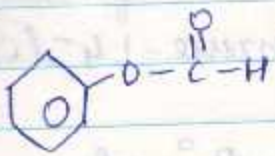
Benzyl =

eg: Benzylic Position

30. 

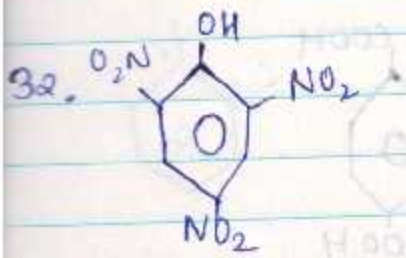
IN: 2- Methyl (2-hydroxy Benzoate

CN: Oil of wintergreen

31. 

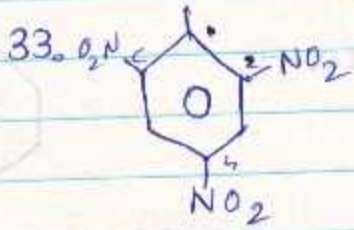
IN: Phenyl methanoate

CN: Phenyl Formate

32. 

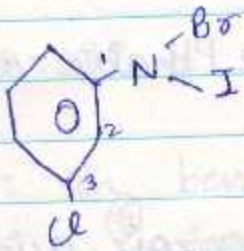
IN: 2,4,6-trinitro phenol

CN: Picric acid

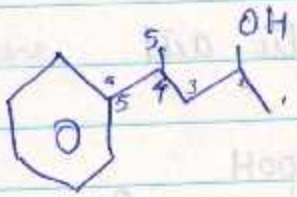
33. 

IN: 2,4,6 trinitro toulene

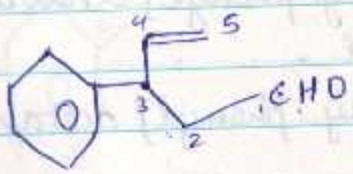
CN: TNT

34. 

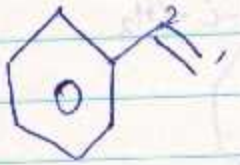
IN: N-Bromo-3-chloro-N-iodo aniline

35. 

IN: 4-~~benzo~~ phenyl pentan-2-ol

36. 

IN: 3-phenyl pent-4-enal

37. 

IN: phenyl ethene

CN: Styrene

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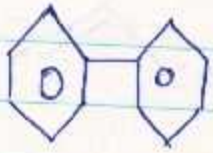
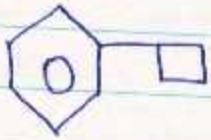
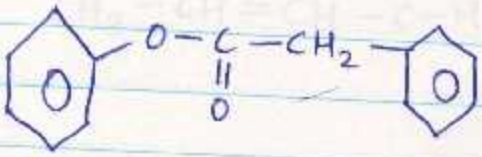
38. 

⇒ Biphenyl

39. 

⇒ Cyclobutyl benzene

40. ** 

⇒ phenyl 2-phenyl ethanoate

* Common Names in Organic Chemistry :→

• Allyl : The position adj. to the double bond is Allylic position

a)

⇒ Allyl alcohol { only in this particular case }

b)

⇒ Allyl Amine

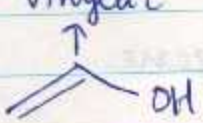
c)

⇒ Allyl chloride

d)

⇒ Allyl Bromide

• Vinyl :

a) 

⇒ Vinyl alcohol

b)

⇒ Vinyl Amine

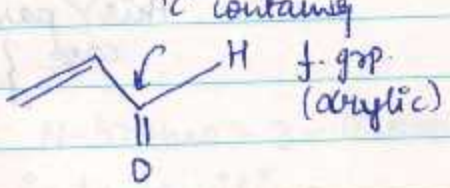
c)

⇒ Vinyl chloride (units of this form PVC pipes)

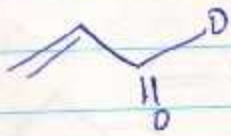
d)

⇒ Vinyl Bromide

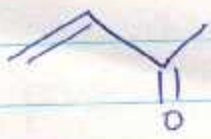
• Acryl :

a) 

⇒ Acrylaldehyde (Acrolein)

b) 

⇒ Acrylic acid

c) 

⇒ Acrylamide

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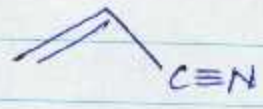
d)  ⇒ Acrylonitrile

- Croton :

a) $CH_3-CH=CH-\overset{\overset{O}{\|}}{C}-H$ ⇒ Crotonaldehyde

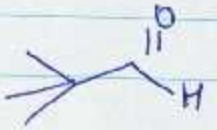
- Cinnam :

a) $Ph-CH=CH-CHO$ ⇒ Cinnamaldehyde

b) $PH-CH=CH-COOH$ ⇒ Cinnamic acid

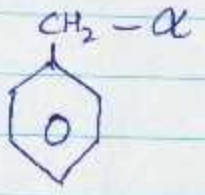
- ⇒ Valeraldehyde

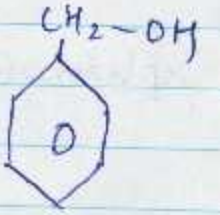
⇒ Isovaleraldehyde

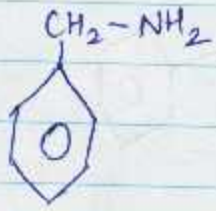
 ⇒ Pivaldehyde

} $C_5H_{10}O$ Isomers

- Benzyl :

a)  Benzyl

 Benzyl Alcohol

 Benzyl Amine

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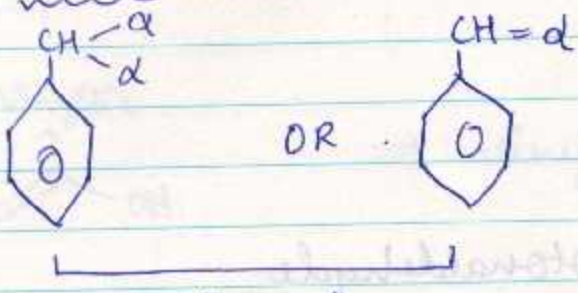
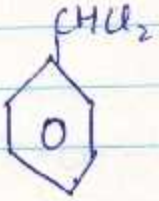
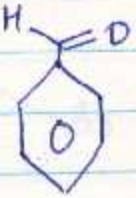
- **Benzal :**



Benzal

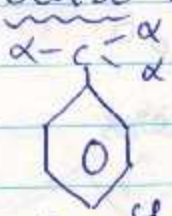
a) 

⇒ Benzal chloride

b) 

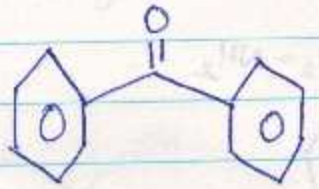
⇒ Benzaldehyde

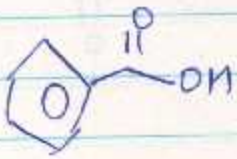
- **Benzo :**



a)

⇒ Benzochloride

b) 
⇒ Benzophenone

c) 

⇒ Benzoic acid

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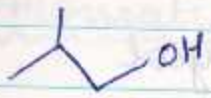
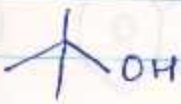
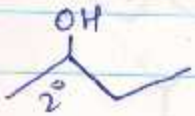
-  ⇒ Isobutyl alcohol

 ⇒ t-butyl alcohol

⇒ Neopentyl alcohol

- ⇒ Isopentane

⇒ Neopentane

 ⇒ sec. butyl alcohol

- Dicarboxylic Acid :→

n	$HOOC-(CH_2)_n-COOH$	name
0	$HOOC-COOH$	Oxalic acid
1	$HOOC-CH_2-COOH$	malonic acid
2	$HOOC-CH_2-CH_2-COOH$	Succinic acid
3	$HOOC-(CH_2)_3-COOH$	Glutaric acid
4	$HOOC-(CH_2)_4-COOH$	Adipic acid
5	$HOOC-(CH_2)_5-COOH$	Pimelic acid
6	$HOOC-(CH_2)_6-COOH$	Suberic acid

OH ↙ OMSGAPS → COOH

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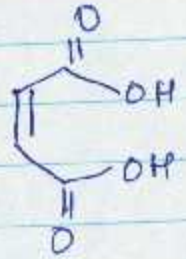
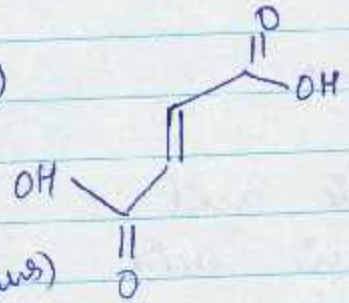
- a) CH_2-OH / CH_2-OH ⟹ Ethylene glycol or glycol

b) CH_2OH / CH_2OH / CH_2OH ⟹ glycerol

c) CHO / CHO ⟹ glyoxal

- a)  ⟹ Maleic acid

(cis)

b)  ⟹ Fumaric acid

(Trans)

- $CH_3-\underset{OH}{CH}-COOH$ ⟹ lactic acid

- HOOC − CH(OH) − CH(OH) − COOH ⟹ Tartaric acid

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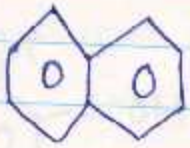
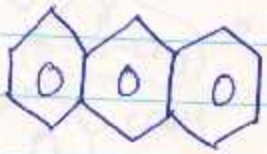
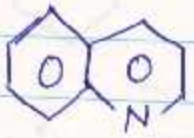
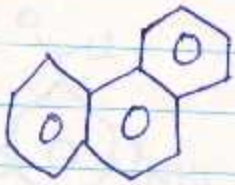
- Aromatic :→

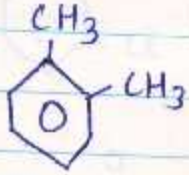
a)  ⇒ Napthalene

b)  ⇒ Anthracene

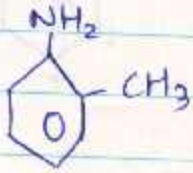
c)  ⇒ Quinoline

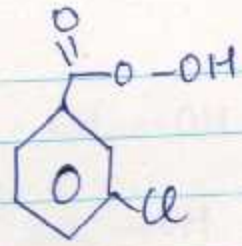
d)  ⇒ Phenanthrene

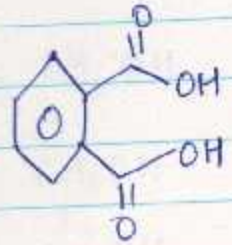
e) ⇒ Isopropyl

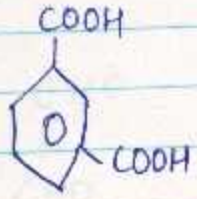
f)  ⇒ O-xylene

g) ⇒ N,N-dimethyl-p-toluidine

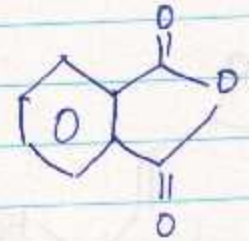
h)  ⇒ O-Toluidine

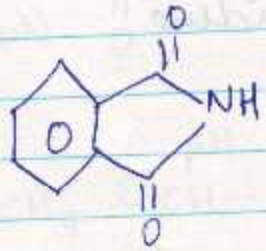
i)  ⇒ MCPBA

j)  ⇒ Phthalic acid

k)  ⇒ Isophthalic acid

l) ⇒ Terephthalic acid

m)  ⇒ Phthalic anhydride

n)  ⇒ Phthalimide

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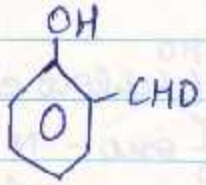
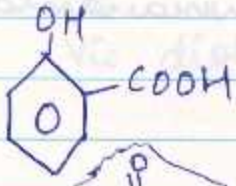
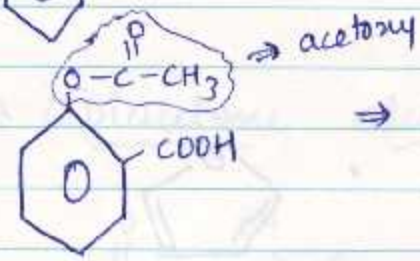
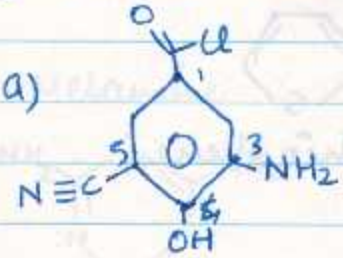
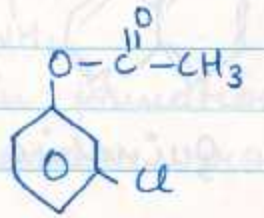
o)  ⇒ Salicaldehyde

p)  ⇒ Salicylic acid

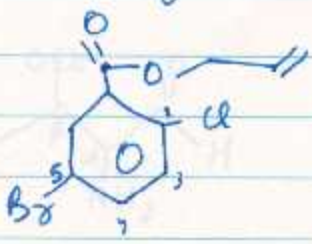
q)  ⇒ Aspirin

Q. Write the IUPAC names of following compounds:

a)  ⇒ 3-amino-5-cyano-4-hydroxy Benzene carbonyl chloride

b)  ⇒ 3-chloro phenyl ethanoate (Acetate)

c) ⇒ cyclohexane-1,2-dicarbonylic anhydri

d)  ⇒ prop-2-enyl-5-Bromo-2-chloro Benzene carboxylate

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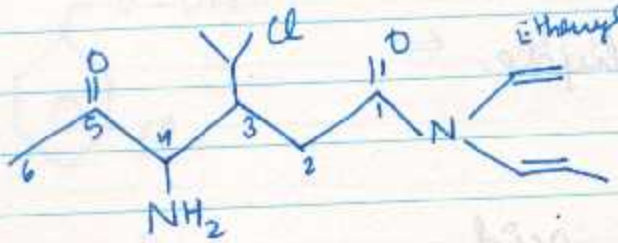
e) 

⇒ 4-amino-3-(1-chloro ethyl)-N-ethenyl-5-oxo-N-propenyl hexanamide

• Common names :→

a)
oxirane

•
oxetane

•
Furan

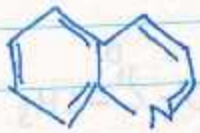
•
Tetrahydrofuran

•
Pyridine

•
Thiophene

•
Pyrolle

•
Piperidine

• 
Quinoline

• Geminal & Vicinal compounds :→

↓ same 2 f. grp./sub. on a given C-atom

→ 2 same grp. on adj. C-atoms

Gem :
Gem diol

Gem chloride

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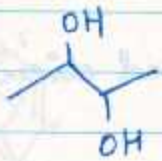
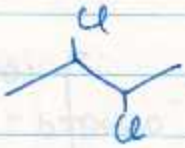
Vic. :

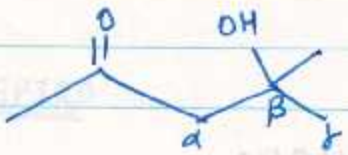


Vic. diol



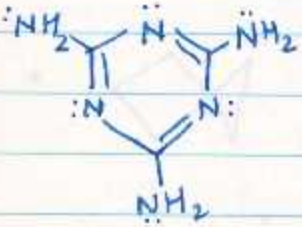
Vic. chloride

- DAA (Diacetone alcohol) :



⇒ It is a type of β-hydroxy ketone

- Melamine



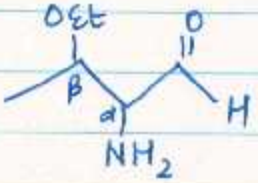
(Used in formation of unbreakable crockery)

- Carbons — Acids

1 → Form
2 → Acet
3 → Propion
4 → Butyr
5 → Valer

- β-hydroxy Butyric acid

-



⇒ α-amino-β-ethoxy butyraldehyde

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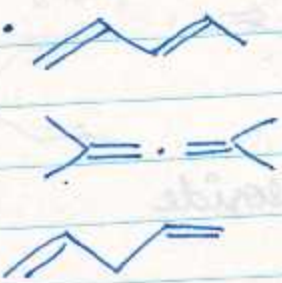
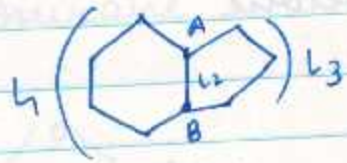
-
Azulene

- 
conjugated diene
cumulative diene
Isolated diene

* Naming of Bicyclo compounds :→

- 

⇒ Bicyclo [4.3.0] nonane

-
⇒ Bicyclo [4.4.0] Decane

-
⇒ Bicyclo [2.2.1] Heptane

-
⇒ Bicyclo [2.2.2] Octane

-
⇒ Bicyclo [3.2.2] nonane

-
⇒ Bicyclo [3.2.1] Octane

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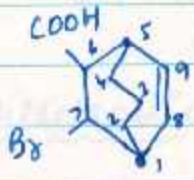
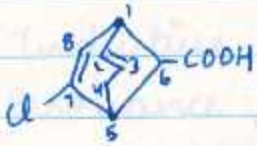
- 

⇒ 7-bromo bicyclo [3.2.2] non-8-ene-6-carbonylic acid.

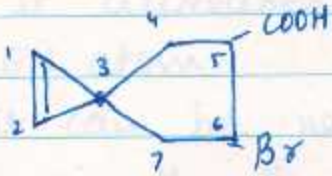
- 

⇒ 7-chloro bicyclo [3.2.1] octa-2,6-diene-8-carbonylic acid

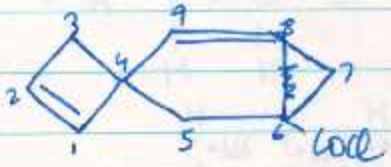
→ SPIRO

-
⇒ spiro [2.4] heptane

-
⇒ spiro [2.3] hexane

- 

⇒ 6-Bromo spiro [2.4] hept-1-ene-5-carbonylic acid

- 

⇒ Spiro [3.5] nona-1,8-diene-6-

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- Previous Year Problems IUPAC analysis :→

1. Naming of substituted benzenes
2. Naming of cyclic compounds (Aliphatic)
3. Use of common names

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2. General Organic Chemistry

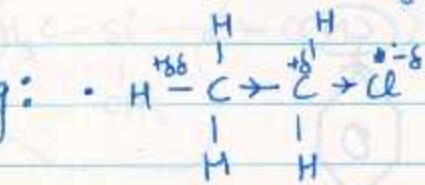
* Electronic displacement effects :→

Permanent	Temporary
- Inductive effect (I)	- Electromeric effect (E)
- Resonance / Mesomeric (M) effect	- Inductomeric effect (IM)
- Hyperconjugation (H)	
- Field Effect (F)	

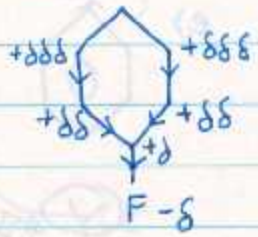
1. Inductive Effect (I) :→

→ It is permanent polarisation of 'c' chain as a result of displacement of sigma (σ) es-
→ It is a weak effect
→ It decreases with increase in distance from EN atom
→ It can be neglected after 3 'c' atoms.

eg: •



•



• There are two types of groups showing I-effe
- I-effect of H-atom is assumed to be zero. So I-effect of other groups is measured relative to hydrogen

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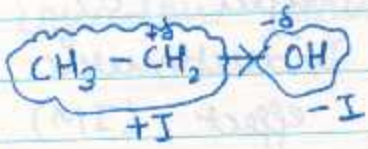
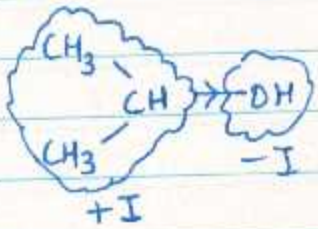
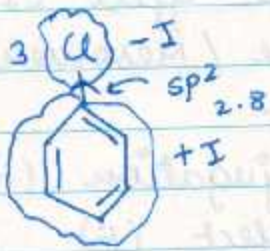
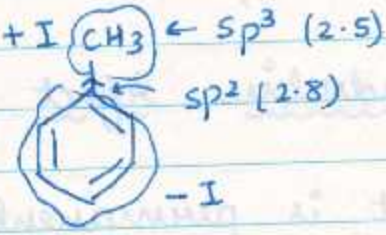
- groups showing +I have greater e^- releasing capability relative to 'H'.
- groups showing -I have greater e^- withdrawing capability w.r.t 'H'.
- this effect is relative and not absolute.







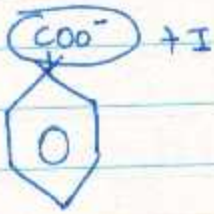


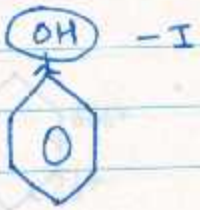
Q. Identify +I / -I

a)

b)

c)

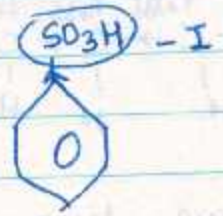
d) 

e) 

f)

g)

h)

i) 

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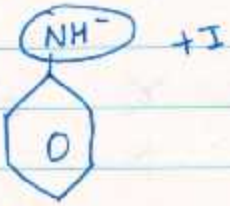
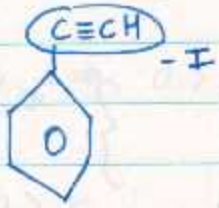
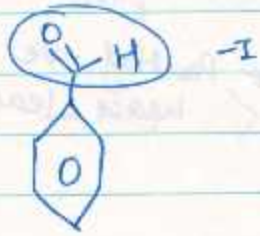
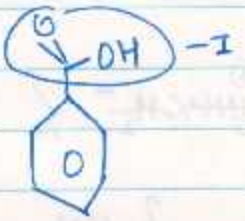
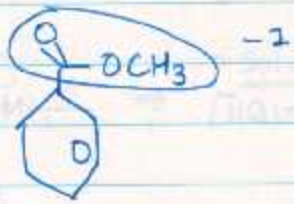
j)

k) 

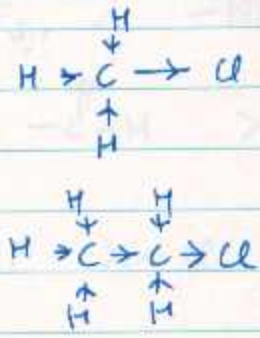
l) 

m) 

n) 

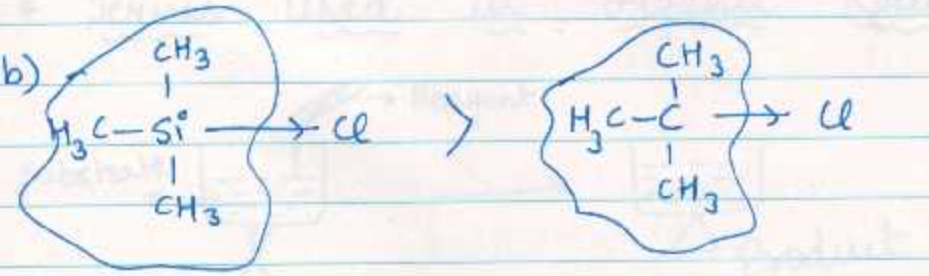
o) 

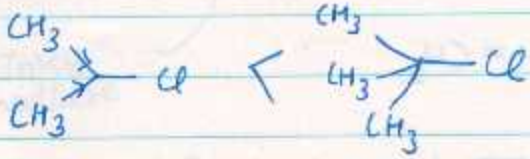
Q. compare +I :→

a) 

+I increases as "pipelines" ↑.

$CH_3 - CH_2 \rightarrow CH_2 \rightarrow Cl$

b) 

c) CH_3-CH_2Cl < 

d) $>C-T$
$>C-D$
$>C-H$
+I decreases

Heavier isotopes form stronger bonds coz of lesser vibrational frequency and stronger overlapping.

B.S. order ⇒ C-T > C-D > C-H

e) $-CD_3$, $-CT_3$, $-CH_3$ } $b > a > c$.

f) $-O^-$, $-NH^-$, $-CH_2^-$, $-\overset{O^-}{\overset{|}{C}}=O$ ← Partial -ve hence least

$d < a < b < c$. } EN.

Q. Compare "-I" :-

a) $-F > -Cl > -Br > -I$

b) $-OH > -OR$

c) $-NO_2 > -CN$

d) $-\overset{O}{\overset{\|}{C}}-OH > -\overset{O}{\overset{\|}{C}}-NH_2$

e) $-\overset{O}{\overset{\|}{C}}-H > -\overset{O}{\overset{\|}{C}}-R$

f) $-\overset{O}{\overset{\|}{C}}-OH > -\overset{O}{\overset{\|}{C}}-OR$

g) $-C\equiv CH \not> -CH=CH_2$

h) $-CH=CH_2 <$

i) $-C\equiv N \not> -CH=NH$

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j) $-\overset{O}{\overset{\|}{C}}-Cl > -\overset{O}{\overset{\|}{C}}-OCH_3 > -\overset{O}{\overset{\|}{C}}-NH_2 \Rightarrow a > b > c$

k) $-\overset{\oplus}{N}F_3 > -\overset{\oplus}{N}H_3 \Rightarrow a > b$

l) $-\overset{\oplus}{N}R_3 > -\overset{\oplus}{N}H_3 > -\overset{\oplus}{N}H_2R > -\overset{\oplus}{N}HR_2 \Rightarrow$ * Solvent! (H-bonding)

* -I order :→

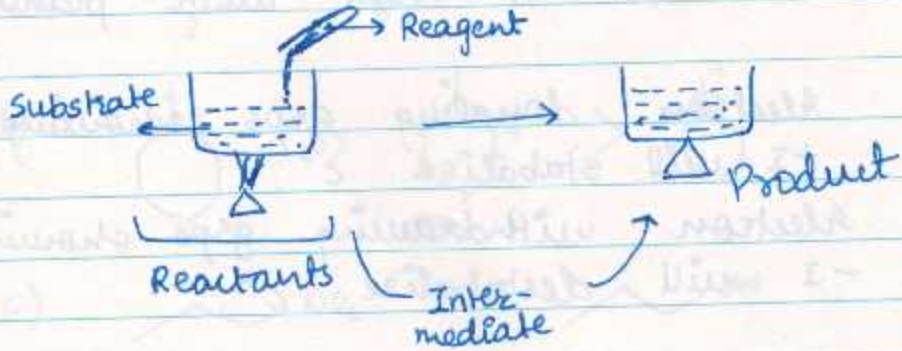
$-NF_3^+ > -NR_3^+ > -NH_3^+ > -NO_2 > -SO_3H > -CN$

$> -\overset{O}{\overset{\|}{C}}-H > -\overset{O}{\overset{\|}{C}}-R > -\overset{O}{\overset{\|}{C}}-OH > -\overset{O}{\overset{\|}{C}}-OR > -\overset{O}{\overset{\|}{C}}-NH_2$

$> -F > -Cl > -Br > -I > -OH > -OR > -C\equiv CH >$

$-Ph > -CH=CH_2 > -H.$

* Terms used in Organic Reaction :→



Types of Intermedia
→ carbocation / C^+
→ carbanion / C^-
→ Free radical / $\dot{C}$
→ Nitrene
→ Carbene, Benzyne

• Intermediates: are highly unstable species which are formed during a reaction. They can be isolated but only under extreme conditions.

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* Types of Bond Breaking :→

i] Heterolytic B.B. :→ When after B.B. es^- are shared unequally

$$A^{\delta+} - B^{\delta-} \longrightarrow A^+ \; B^-$$

eg : • $CH_3-CH_2-Cl \longrightarrow CH_3CH_2^+ \; Cl^-$

↓ carboration (octet incomplete)

• $\longrightarrow$ Cl^-

↓ carbocation

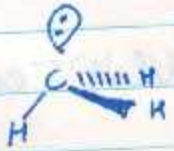
• $CH_3\overset{\delta-}{C}H_2 - \overset{\delta+}{M}gX \longrightarrow CH_3CH_2^- \; Mg^+X$

↓ carbanion (Excess es^-)

* Carbocation : It is +vely charged 'c' having incomplete octet. It is sp^2 hyb. with planar shape.

Electron donating grps showing +I will stabalise c^+.
Electron withdrawing grps showing −I will destabalize c^+.

* Carbanion : It is −vely charged electron rich 'c'. Trigonal pyramidal (sp^3). Electron withdrawing grps showing −I will stabalize carbanion



ii] Homolytic B.B. : It is favourable in non-polar or slightly polar bonds. It is highly favourable in presence of light.

• Free radical is e^- deficient atom having unpaired electron.

$$A \overset{\curvearrowright}{-} A \xrightarrow[\text{light}]{h\nu} 2(\dot{A})$$

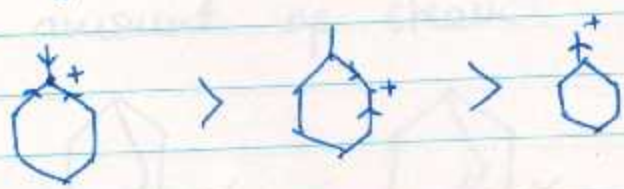
eg : • $Cl \overset{\curvearrowright}{-} Cl \longrightarrow 2\dot{Cl}$

• $R-O\overset{\curvearrowright}{-}O-R \longrightarrow 2R\dot{O}$

• $H_3C\overset{\curvearrowright}{-}CH_3 \longrightarrow 2\dot{C}H_3$

Q. Comparison of stability of intermediates :→

a)

b) 

c)

d)

e)

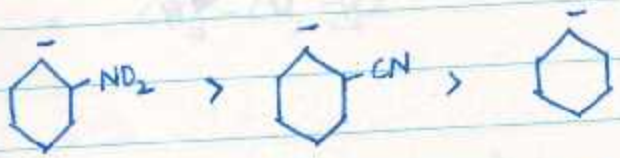
f) $CH_3-\overset{+}{C}H_2 > CH_2=\overset{+}{C}H$

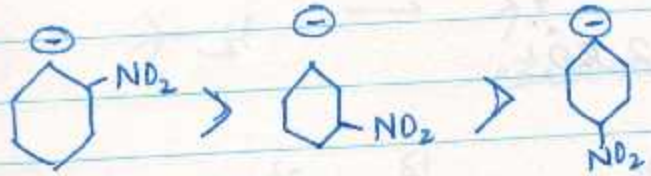
g) $CH_3-\bar{C}H_2 < CH_2=\bar{C}H < HC\equiv C^-$

h) $\bar{C}\equiv N > \bar{C}\equiv C-H$

i) $\bar{C}\equiv N > \bar{C}H=NH$

* Check hyb. of atom which has charge.
* Check es⁻ withdrawing grps.

j) 

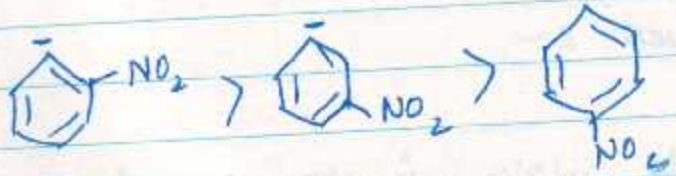
k) 

l)

m)

b) c) a

n)

o) 

p)

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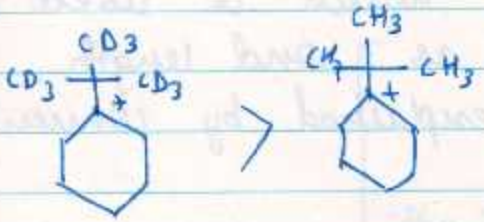
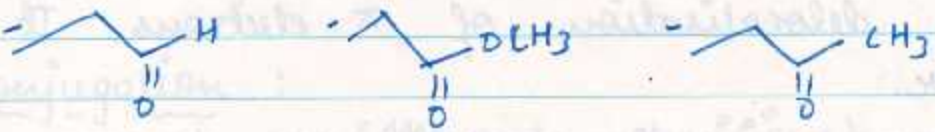
q)

r)

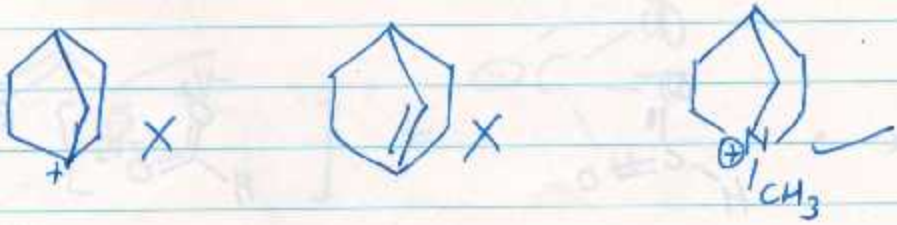
s) 

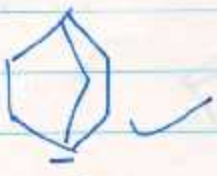
t) $\bar{C}D_3$ $\bar{C}T_3$ $\bar{C}H_3$ $c > a > b$

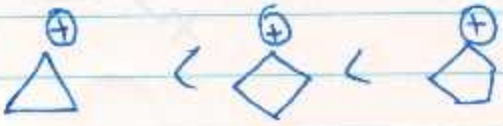
u)  $a > c > b$

v) $b > c > a$

• Bredt's rule : Acc" to this rule, bridgehead atom cannot be sp^2 hybridised. Becoz it causes huge amount of strain.





w)  { Angle strain)

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* RESONANCE :→

· Why Resonance concept is needed ?

→ It is a theortical concept which is used to explain various properties such as bond length, e⁻ density which cannot be explained by conventional structures.

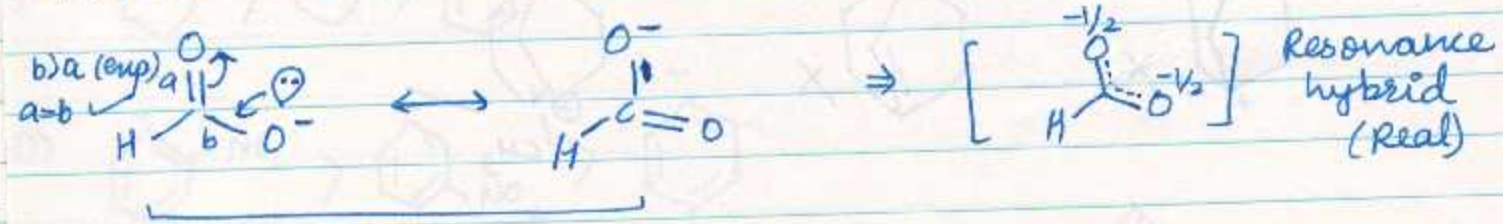
· What is Resonance ?

→ Resonance is delocalisation of π electrons. It occurs only on paper.

- Structures drawn in the process are known as resonating structures / canonical structures / contributing structures.
- Real structure is Resonance hybrid which is formed by mixing R.S.
- Contribution of R.S. ∝ Stability

eg,

· Formate ion,



Resonating structures R.S
(Canonical structures)

Resonance hybrid (Real)

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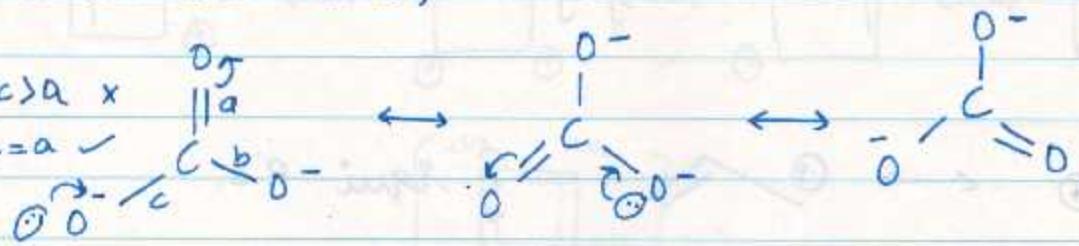
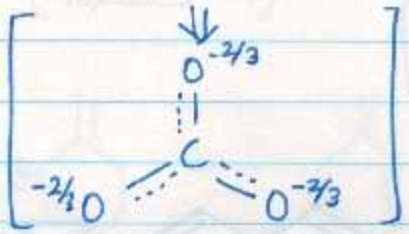
• Carbonate ion,

b=c>a ✗
b=c=a ✓



{ equivalent R.S }



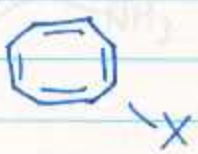
- Resonance is a strong & permanent effect coz it operates thru π-bond

* Conditions for Resonance :→

1] Conjugation :

(Alternate positions)

2] Planarity :



→ No resonance as vacant orbitals are not in same plane.

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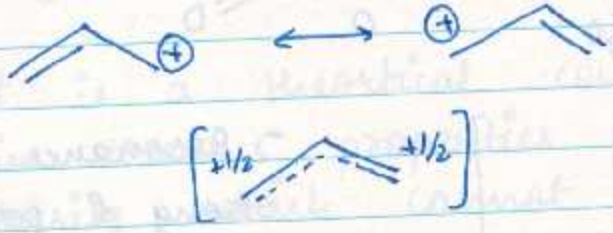
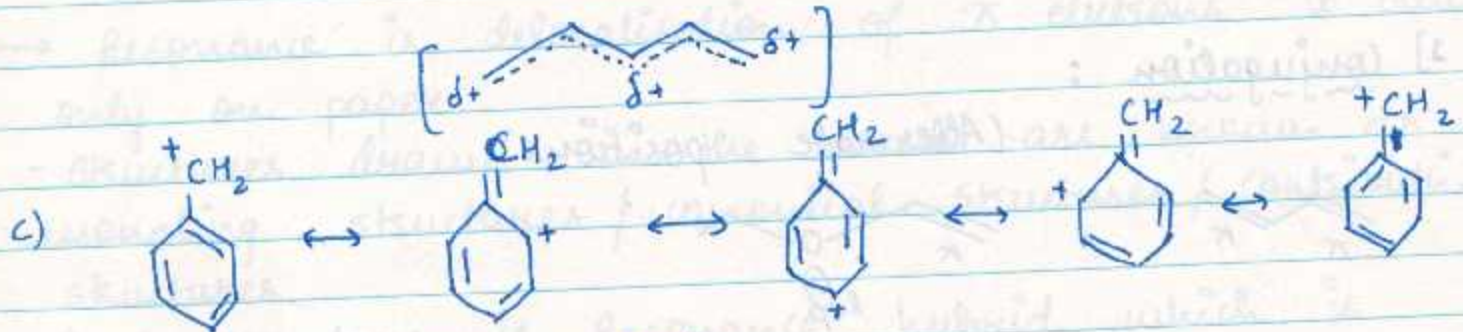
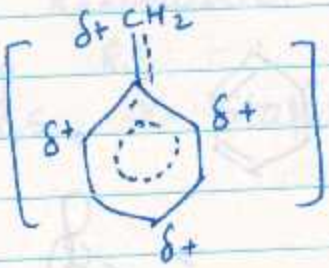
C-1 : When π-bond is in conjugation with vacant p-orbital.

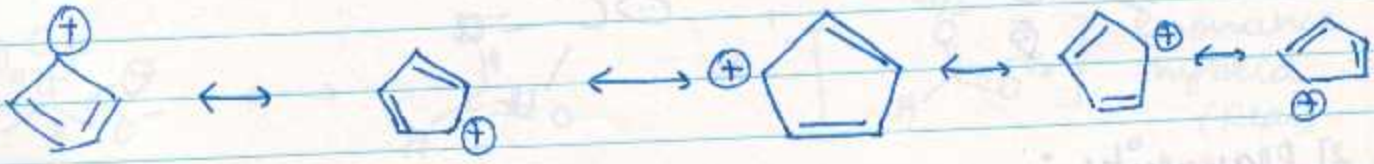
a)  } Equi. R.S.

b)

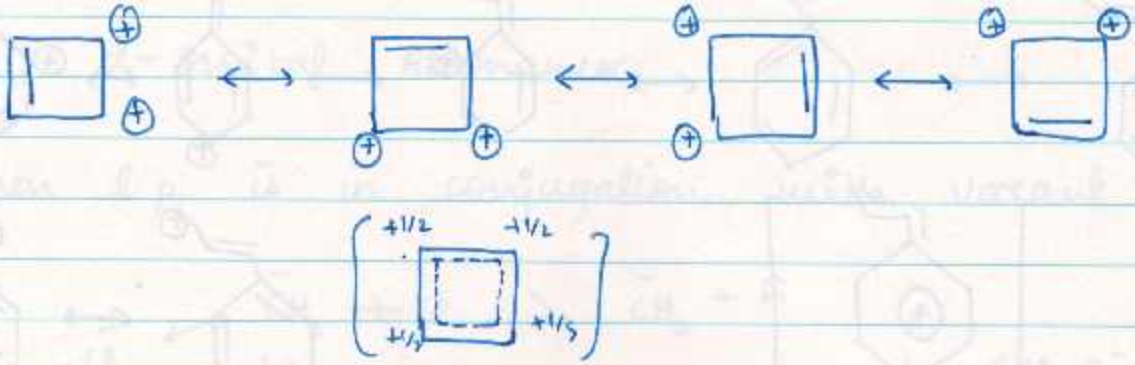
c) 

Benzyl cation

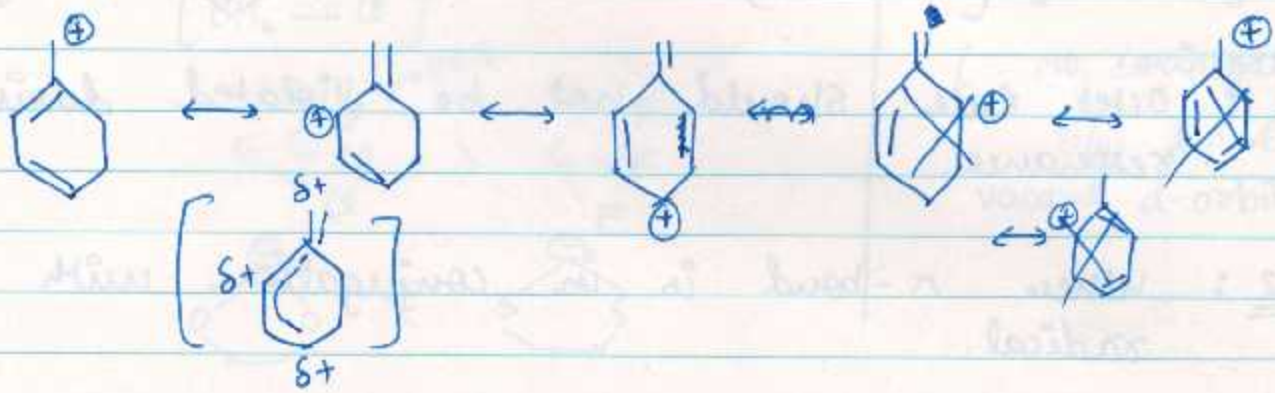


d) 

e)



f)



g)

h)

i)

~~X~~ NO RESONANCE

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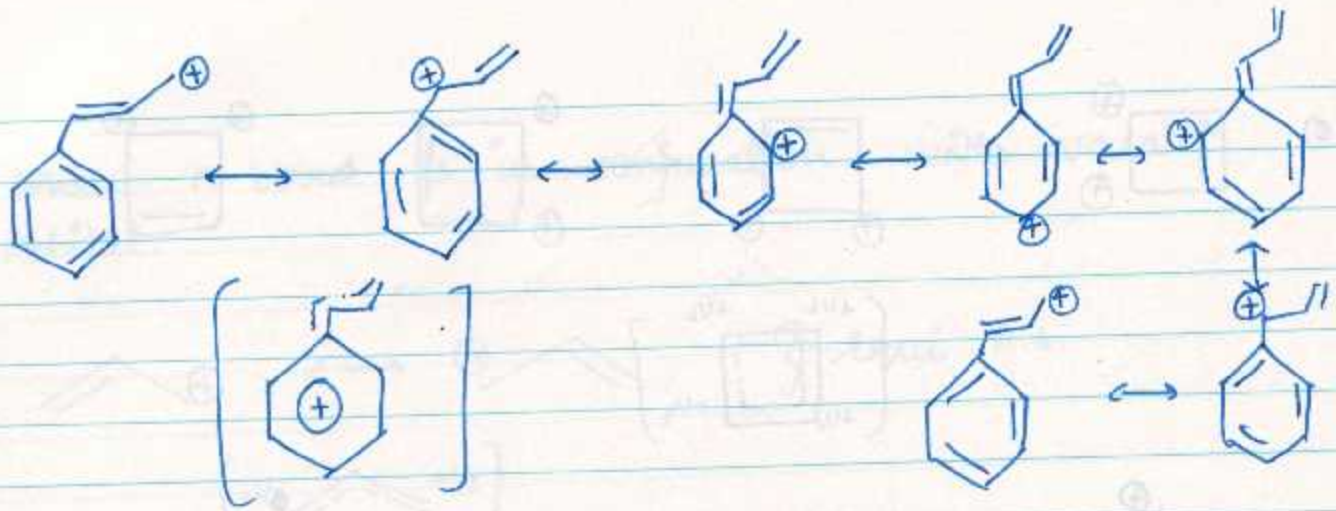
j)



Note : Octet Rule should not be violated during resonance.

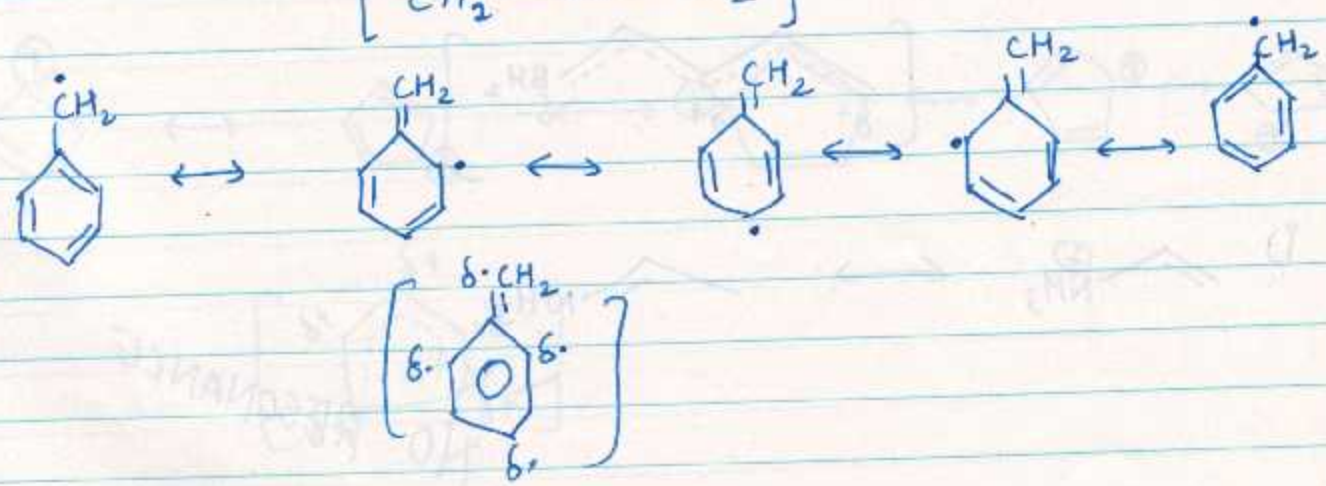
C-2 : When π-bond is in conjugation with free radical.

- Break π-bond in homolytic manner
- In R.S. no. of unpaired e^- must remain same

a) $CH_2 = CH - \dot{C}H_2 \longleftrightarrow \underbrace{\dot{C}H_2 - \cancel{\dot{C}H} - \dot{C}H_2}_{\text{unstable}} \longleftrightarrow \dot{C}H_2 - CH = CH_2$

$$\left[\overset{\delta\cdot}{C}H_2 \cdots CH \cdots \overset{\delta\cdot}{C}H_2 \right]$$

b)



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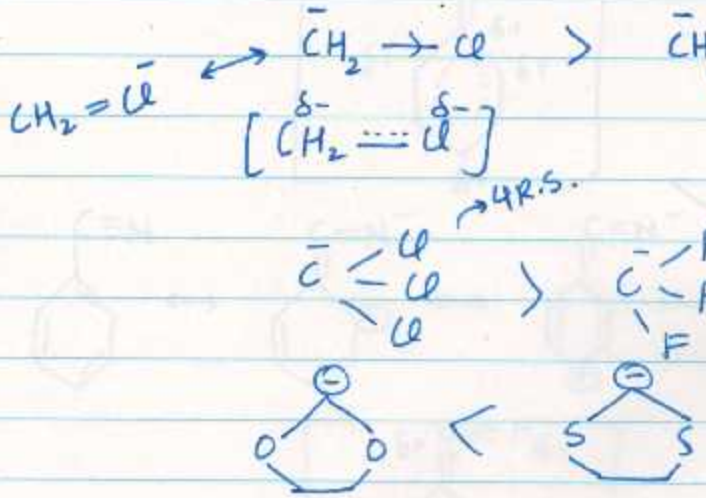
C-3 : d-orbital Resonance

⇒ When l.p. is in conjugation with vacant d-orbital

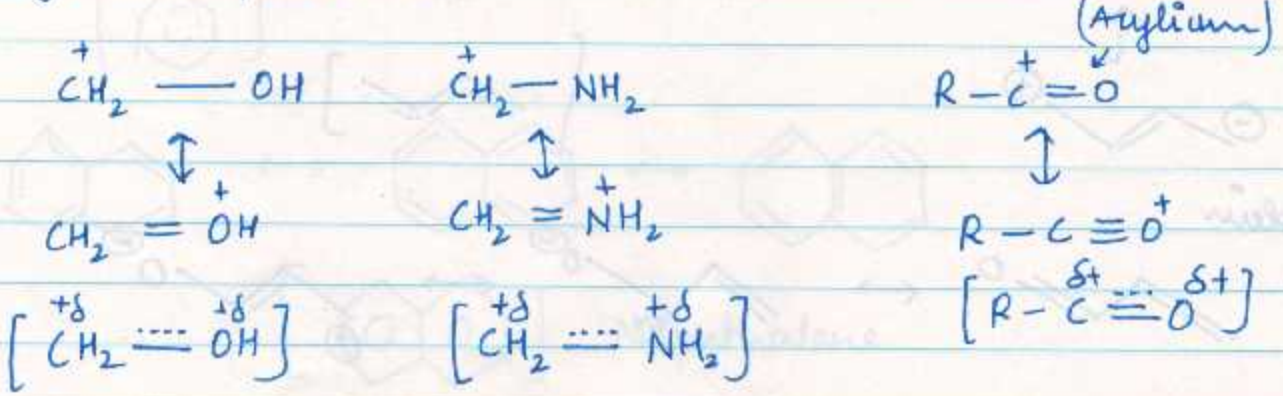


$CCl_3O^- < CF_3O^-$

(∵ No conjugation b/w l.p. & vacant d-orbital

C-4 : O·C·C$^+$ l.p. in conjugation with vacant p-orbital

This type of resonance is highly effective in stabalising carbocation coz octet gets completed during the process.



Q.

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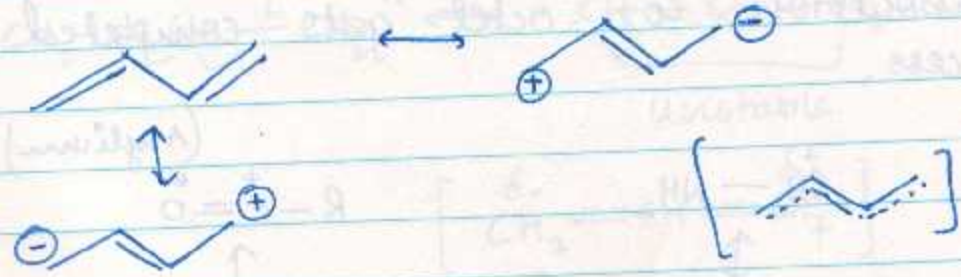
Q. Compare Stability :→

a) a > c > b

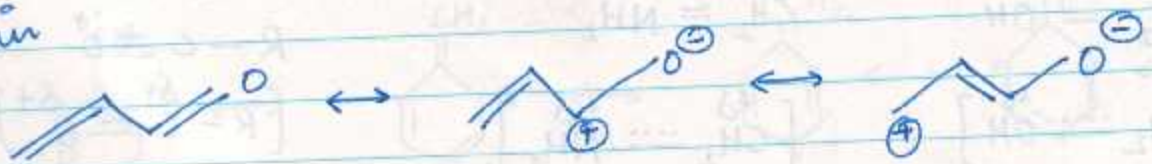
b)

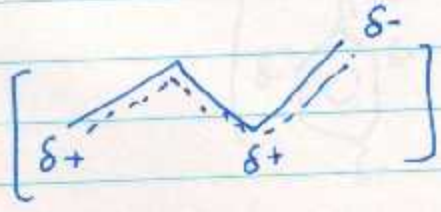
c)

C-5 when π-bond is in conjugation with another π-bond.

a) 

acrolein

b) 



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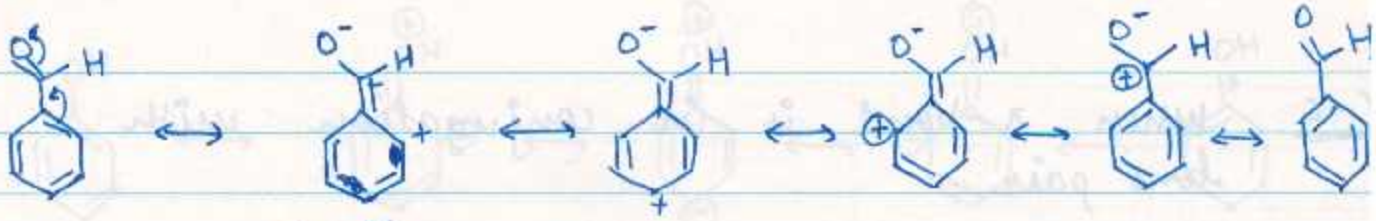
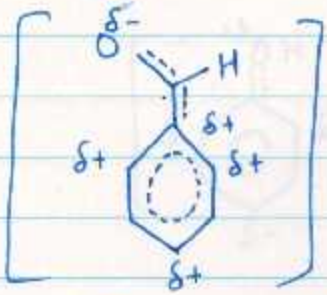
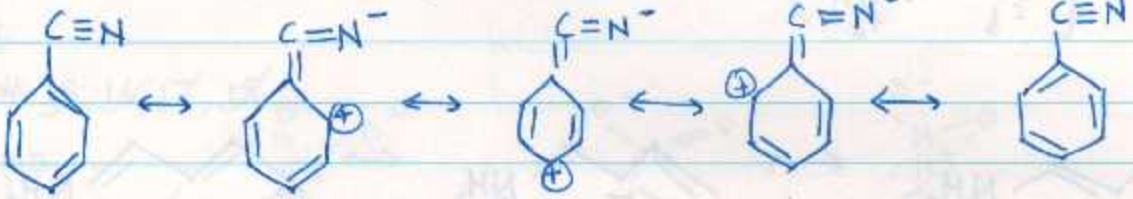
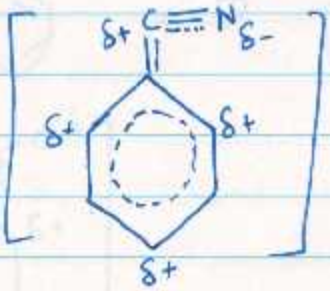
c) 

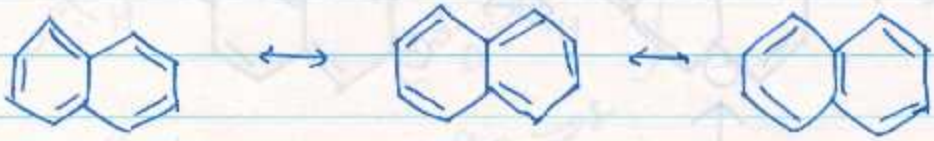


d) 

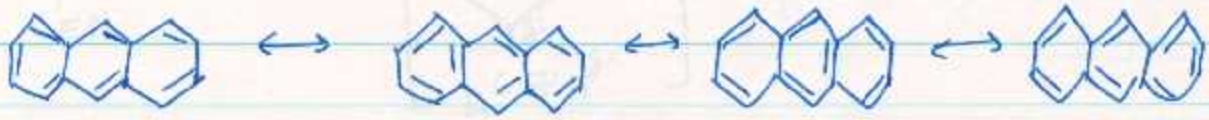


e)

Benzene has significant R.S.

f) 

Naphthalene

g) 

Anthracene

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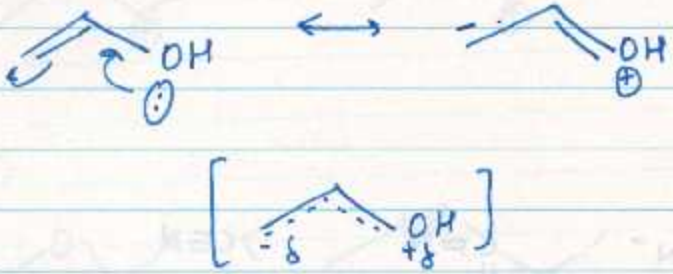
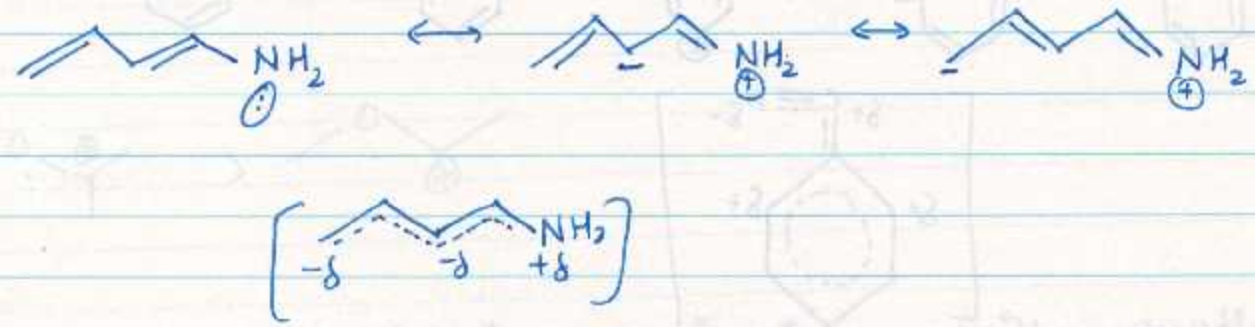
C-G When π-bond is in conjugation with lone pair.

a)

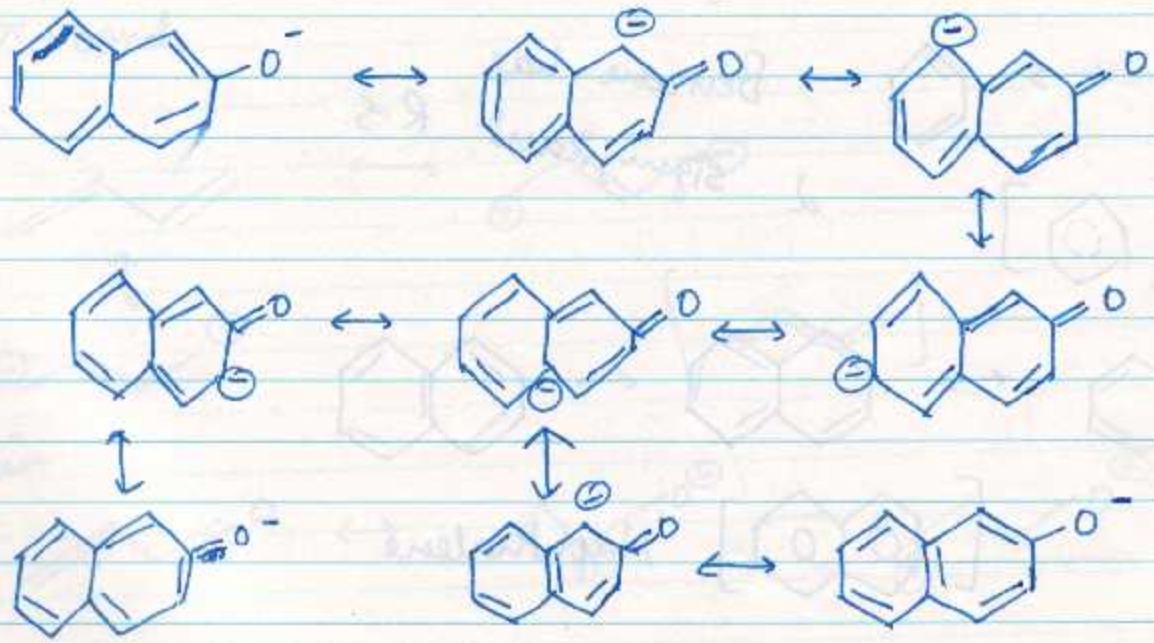


b)



JEE *

c)



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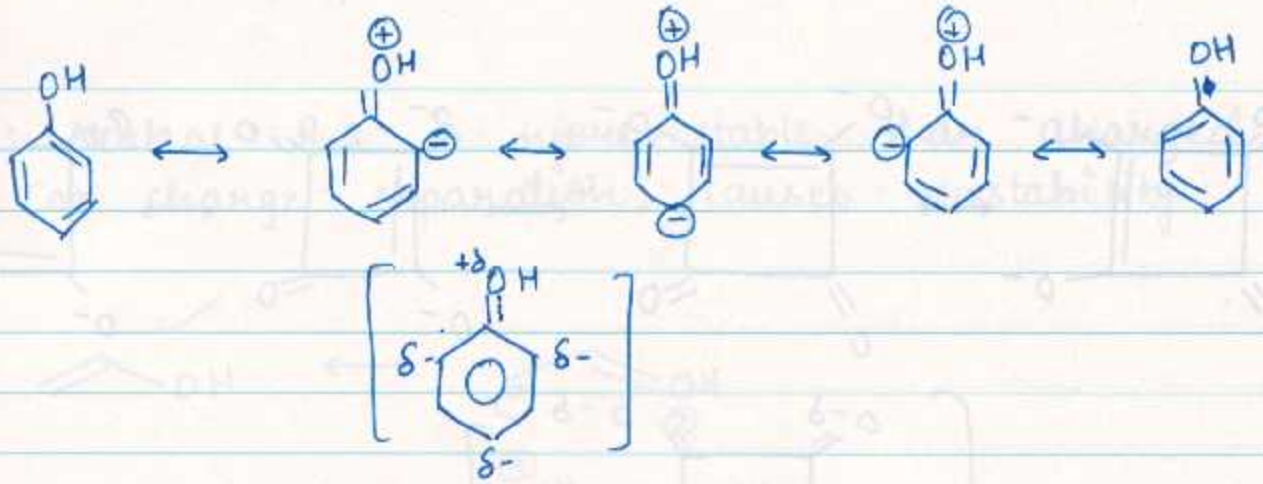
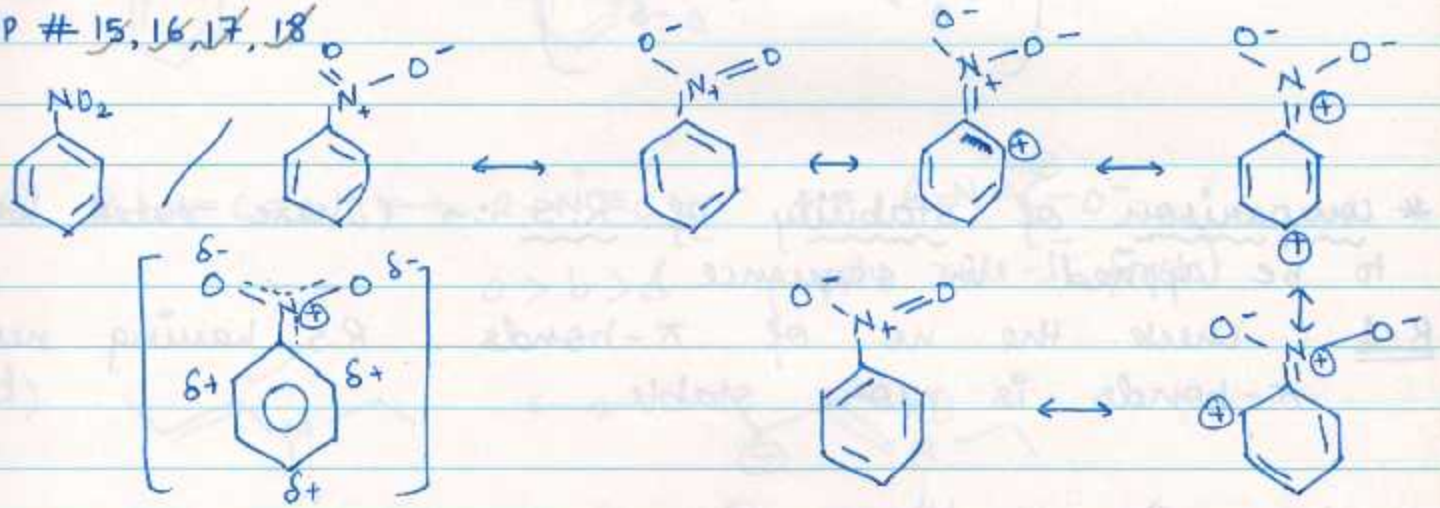
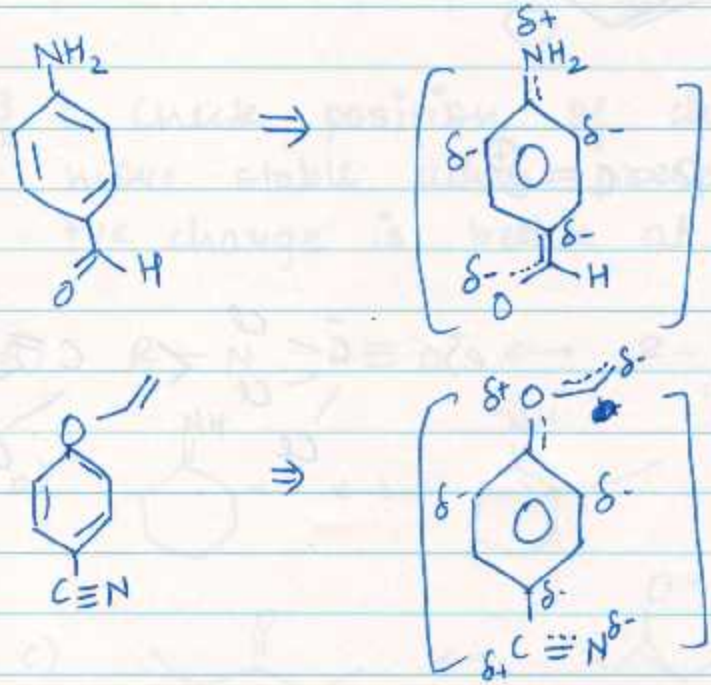
d)



H.W.

DPP # 15, 16, 17, 18





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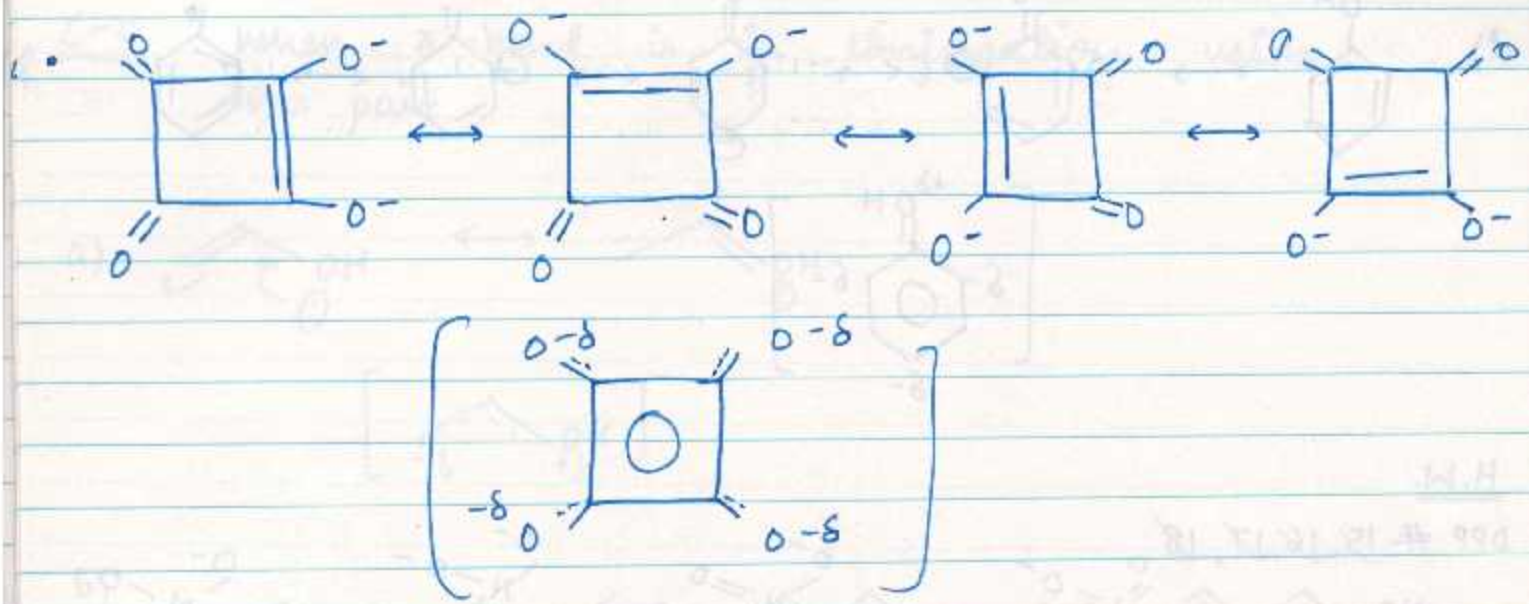


* comparison of stability of R.S. :→ (These rules have to be applied in sequence)

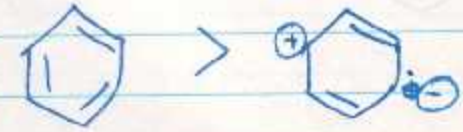
R-1 : Check the no. of π-bonds. R.S. having more π-bonds is more stable.

a)

b) $R-\overset{\oplus}{C}=O \quad < \quad R-C\equiv\overset{\oplus}{O}$

c)

e)

d) 

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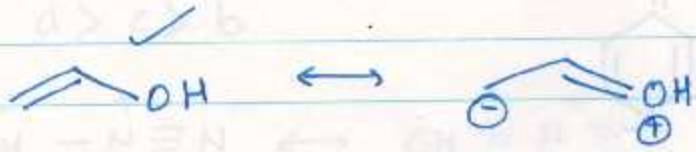
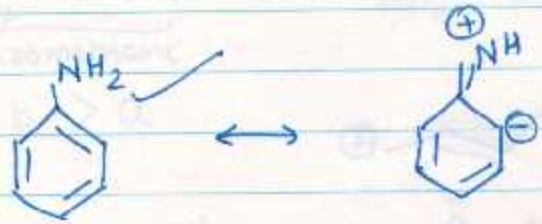
R-2 : Neutral R.S. is more stable than charged. Coz charge separation causes unstability

a) 

b) 

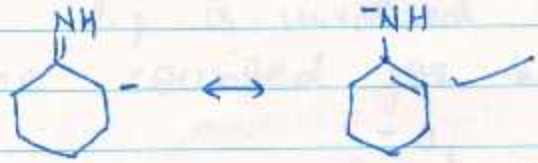
c) $R-N=C=O \leftrightarrow R-\overset{+}{N}\equiv C-O^- \leftrightarrow R-N=\overset{\oplus}{C}-O^-$

a > b > c (Apply rule-1 first)

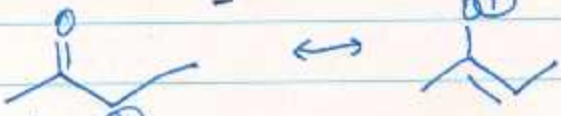
d)

R-3 : Check position of charge. -ve charge is more stable when present on more EN atom. +ve charge is better at less EN atom.

a) $R-\bar{N}-C\equiv O^+ \leftrightarrow R-N^+\equiv C-O^-$

b) 

c)

d) 

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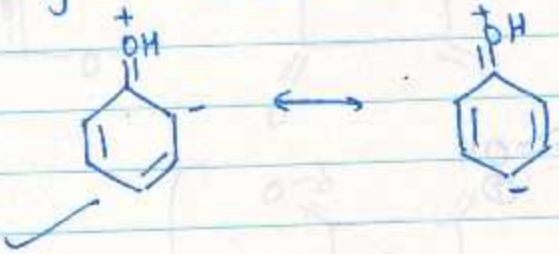
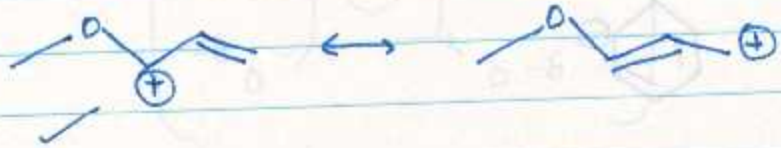
• R-4 : Unlike charges should be closer and like charges should be distant.

a) 

b) 

c)

R

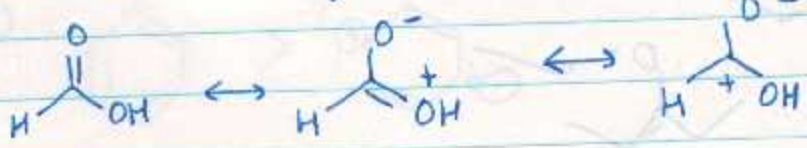
Q. Compare stability :→

1) $O=\overset{a}{C}=O \leftrightarrow O^--\overset{2+}{\overset{b}{C}}-O^- \leftrightarrow O^-\overset{c}{-}C\equiv O^+ \leftrightarrow \overset{d}{O^+}\equiv C-O^- \leftrightarrow O^-\overset{e}{-}C^+=O$

→ a > c ≡ d > e > b

2) $R-N=\overset{a}{C}=O \leftrightarrow R-\overset{+}{N}\equiv\overset{b}{C}-O^- \leftrightarrow R-\overset{-}{N}-\overset{2+}{\overset{c}{C}}-O^- \leftrightarrow R-\overset{d}{\bar{N}}-C\equiv O^+ \leftrightarrow R-N=\overset{e}{C^+}-O^- \leftrightarrow R-\overset{f}{\bar{N}}-C^+=O$

→ a > b > d > e > f > c

3) 

→ a > b > c

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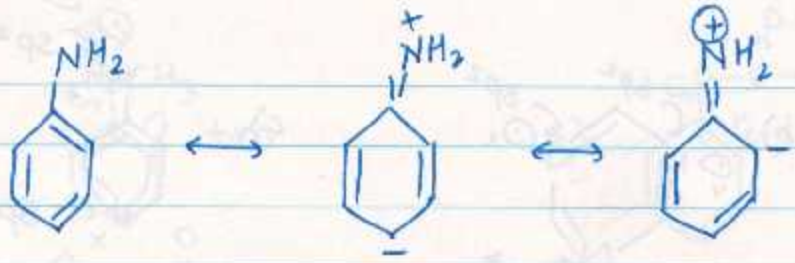
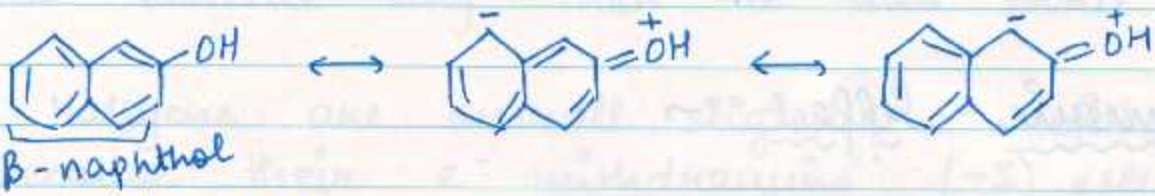
4) 

→ a > c > b

5) $\overset{-}{C}H_2 - \overset{+}{N} \equiv N \longleftrightarrow CH_2 = \overset{+}{N} = \overset{-}{N}$

Diazomethane

→ b > a

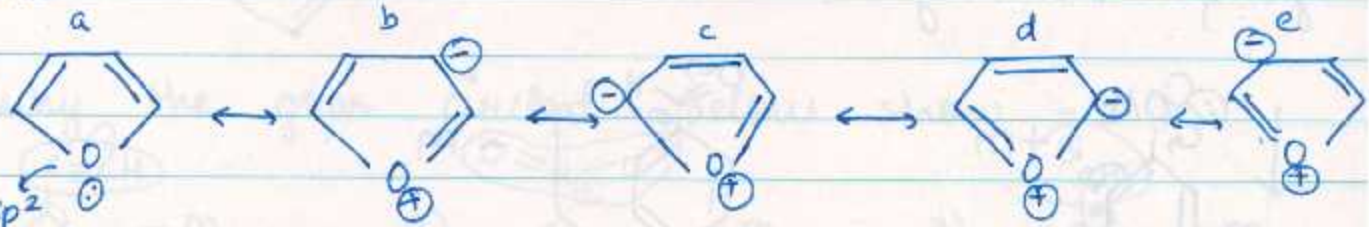
6) 

β-naphthol

→ a > c > b

H.W.

DPP #19

Q. 

Stability,

a > b = c = d > b = e

- when l.p. is involved in resonance, it will not be counted for hyb.

Q. Calculate hyb. & comment on which l.p. will participate in resonance :→

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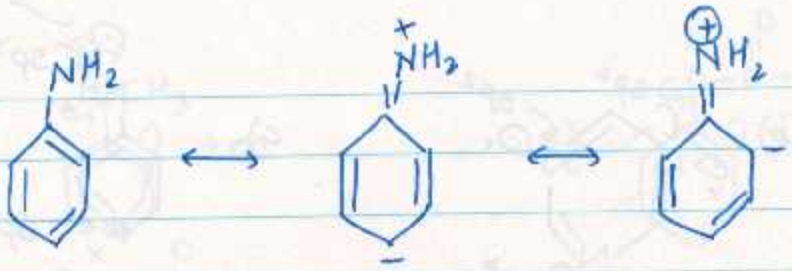
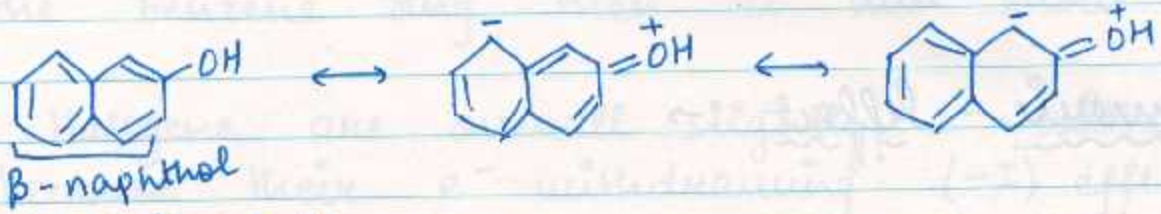
4) 

→ a > c > b

5) $\underset{\text{Diazomethane}}{\overset{-}{C}H_2-\overset{+}{N}\equiv N} \longleftrightarrow CH_2=\overset{+}{N}=\overset{-}{N}$

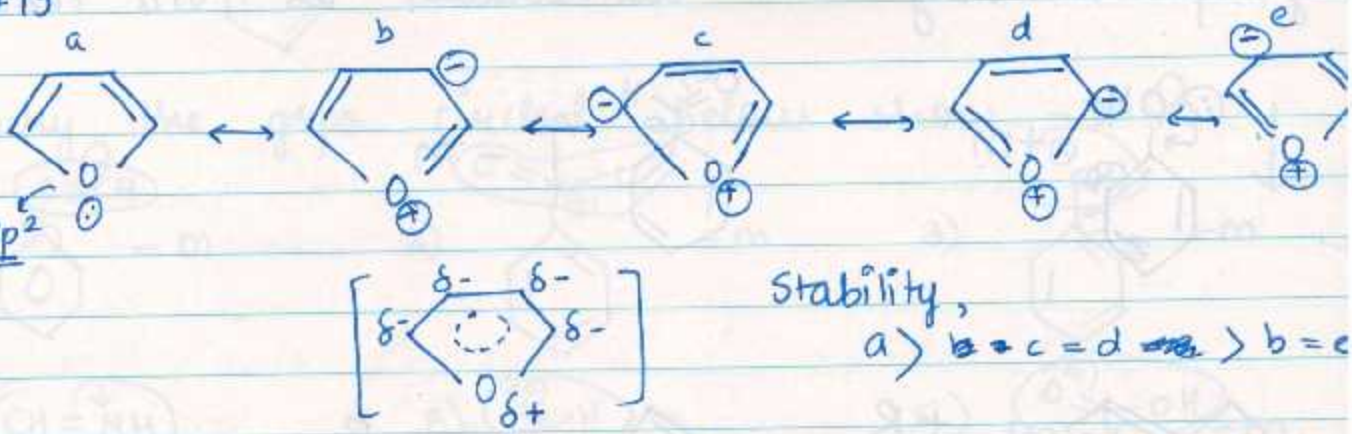
→ b > a

6) 

→ a > c > b

H.W.

DPP #19

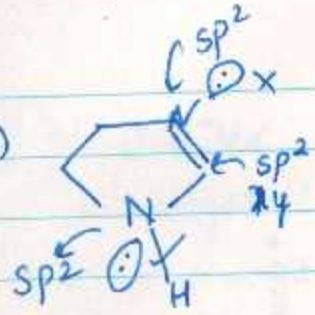
Q. 

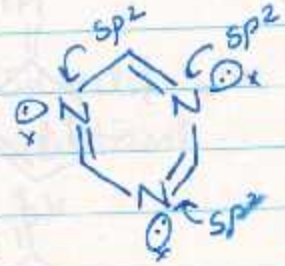
Stability,

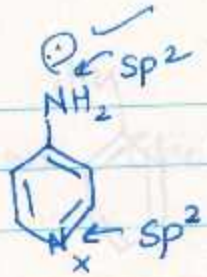
a > b = c = d > b = e

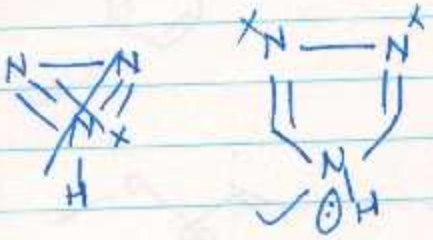
- when l.p. is involved in resonance, it will not be counted for hyb.

Q. Calculate hyb. & comment on which l.p. will participate in resonance :→

a) 

b) 

c) 

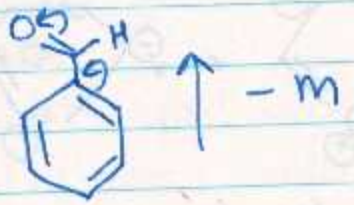
d) 

e)
Thiophene

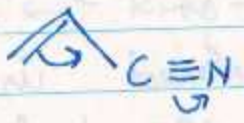
* Mesomeric effect :→

- There are two type of grps in resonance.
- Groups showing "+m" effect donates e^- via resonance.
- Groups showing "-m" withdraws e^- via resonance.

+m


-m

+R


-R.

1)
+m

Q. Why the following grps show +m effect ?

2)
+m

3)
+m

4)
+m

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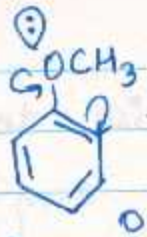
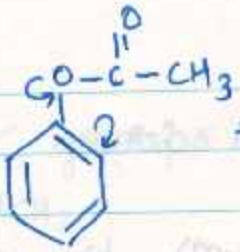
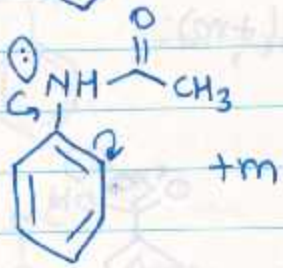
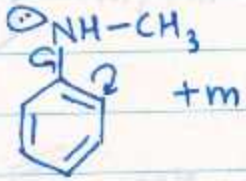
5)  +m

6)  +m

7)  +m

8)  +m

• If l.p. is present on the atom directly attached to the benzene ring then it will show "+m"

Note : Halogens are overall slightly e⁻ withdrawing because their e⁻ withdrawing (−I) effect dominates over +m.

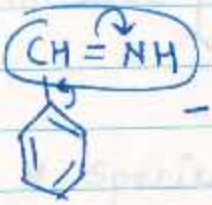
+m < −I

Q. Why the grps circled below show −m?

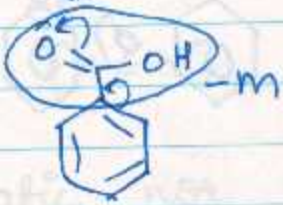
1) −m

2) −m

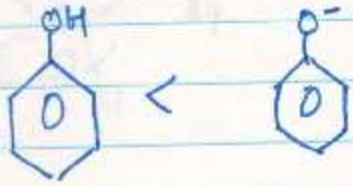
3) −m

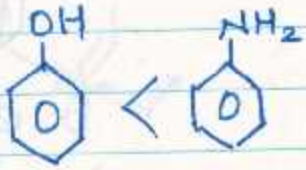
4)  −m

5) −m

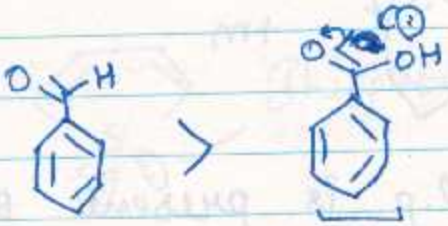
6)  −m

9. Compare +m / -m :→

a)  (+m)

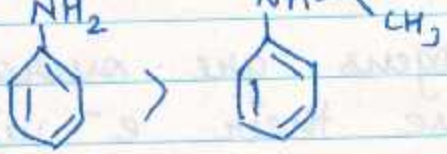
b)  (+m)

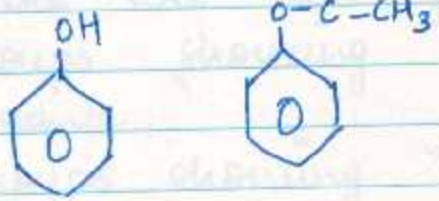
c) (-m)

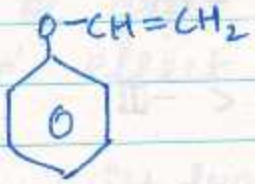
d) 

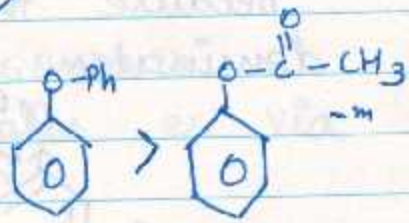
Cross Resonance

e)

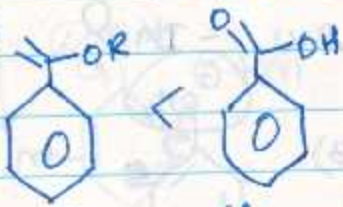
f) 

g) 

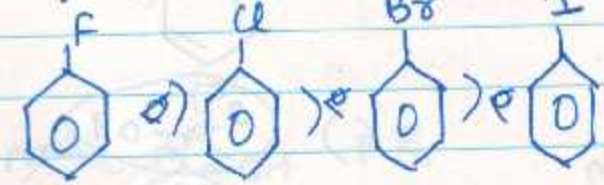


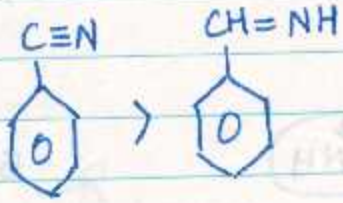
h) 

(a > c > b)

i) 

j)

k) 

l) 

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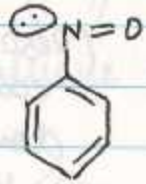
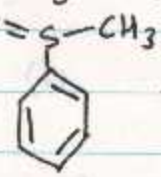
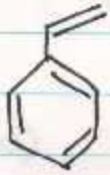
q. What will the following groups show (+m / -m) ?

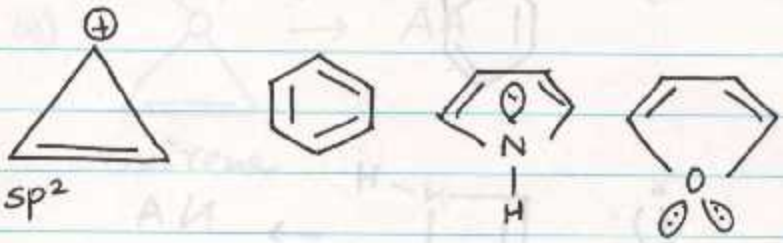
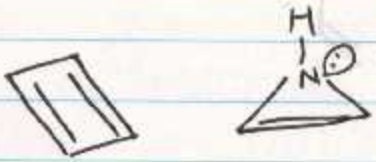
a)  -m / +m

b)  -m / +m

** c) both cannot show anything

d)  weak +m } It will show weak +m

* Concept of Aromaticity :→

Aromatic	Anti-aromatic
	
→ cyclic (at least 1 ring)	✓
→ complete Resonance	✓
→ Planar (sp^2)	✓
→ Hückel's rule $(4n+2)\ \pi$ es^- $\{n \in W\}$	× $4n\ \pi$ es^- $\{n \in N\}$

Species which are neither aromatic nor anti-aromatic may be termed as non-aromatic

While comparing stability of similar type of specie
Aromatic > Non-aromatic > anti-aromatic

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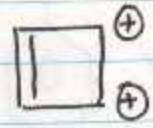
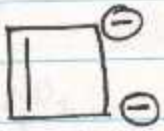
Q. classify the followings as A, AA, NA :→

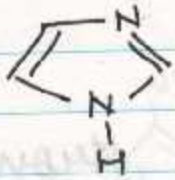
a)  → A

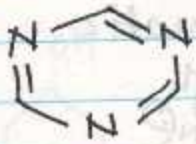
b) → AA

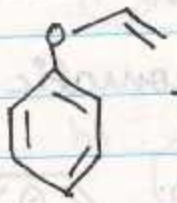
c)  → A

d) → AA (Resonance can be done here)

e) → AA

f)  → AA

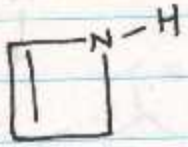
g)  → A

h)  → A

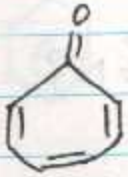
i) → AA

Exocyclic

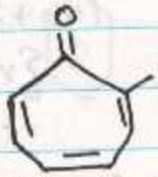
k) → A

j)  → NA

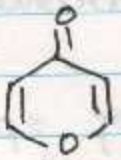
l) → AA

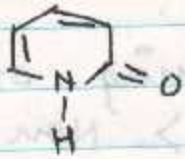
m)  → A

Tropone

n)  → A

Tropolol

o)  → A

p)  → A

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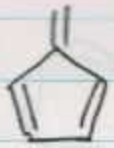
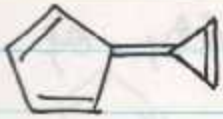
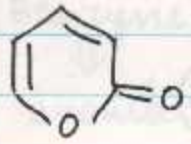
q)  → A

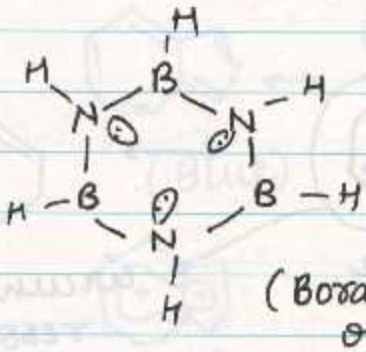
Fulvene

r) → NA

s)  → A

t) → A

u)  → A

v)  → A

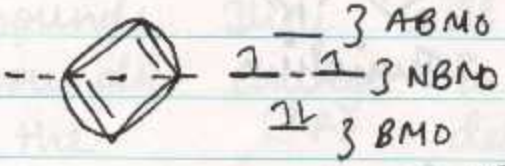
(Borazole or Borazine)

w) → AA

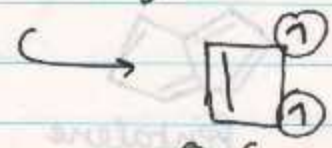
Oxirene

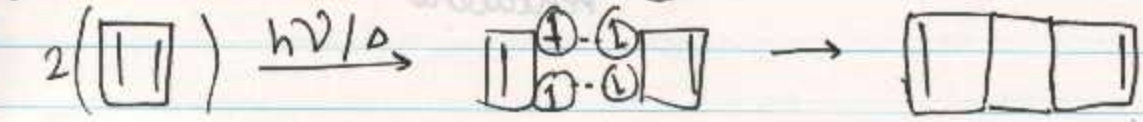
* Frost circle Method :→

All in BMO so stable hence aromatic



Unpaired e⁻ in NBMO causes high reactivity hence anti-aromatic

dimerisation  ⇒ Diradical



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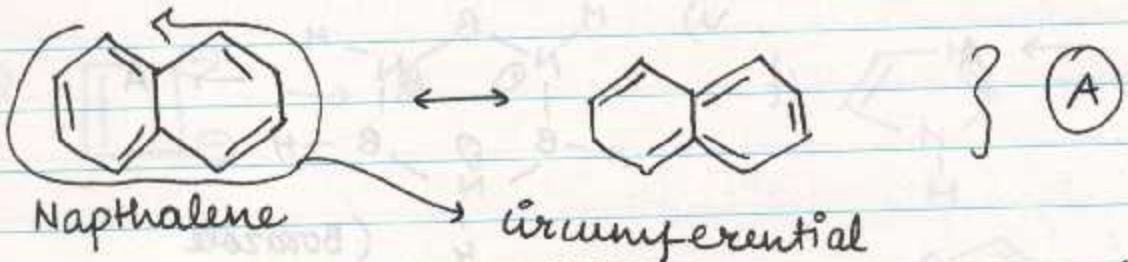
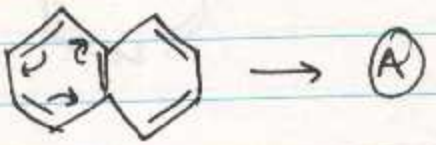
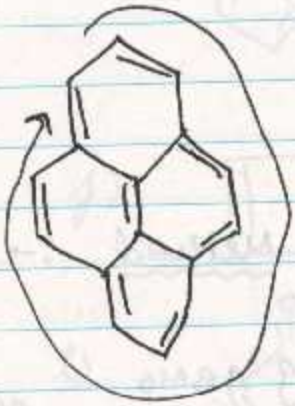
* Fused Rings :→

- In Fused rings, you have to consider the biggest loop.
- You cannot comment about aromaticity of individual rings (fused rings)







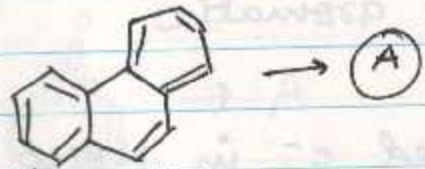
Fries Rule

Benzenoid ↑

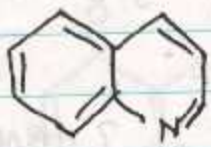
☺ ↑

(Stability R.S. ↑)

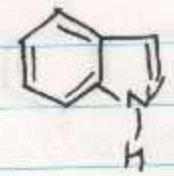
a)



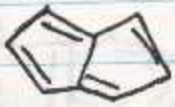
b)



c)



d)



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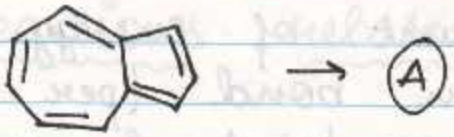
e) 

Azulene

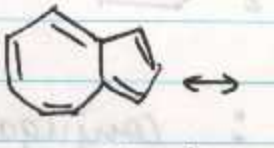
f)

Quasi - Aromatic

g)

Benzyne
⇓
is aromatic but it is highly unstable becoz of very weak π-bond.

* Azulene :



(Blue)

Extended Resonance

- Why organic cmpds are coloured due to extended conjugation ?
→ Due to overlap b/w large no. of p-orbitals, gap b/w HOMO & LUMO decreases So, e^- transition will lie in visible spectrum.

* Quasi Aromatic : Aromatic as well as ionic compounds. They will show properties of ionic compounds. Charge (l.p.) is the part of aromaticity, so, the delocalisation is highly effective.

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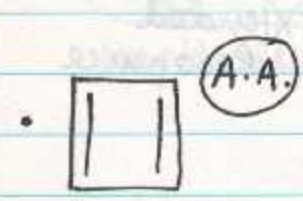
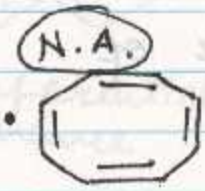
* Rotational Barrier : is amt. of energy needed for rotation across a given bond (per mole). It is very low for a sigma bond & very high for π - bonds.

* Annulene : conjugated monocyclic polyenes

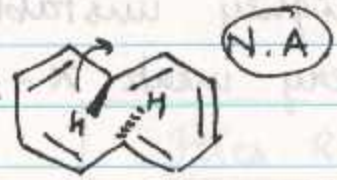


Annulene [4]

Annulene [6]

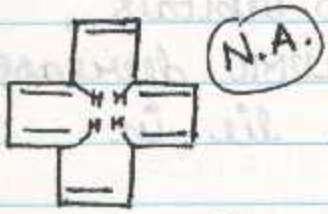


Annulene [8]



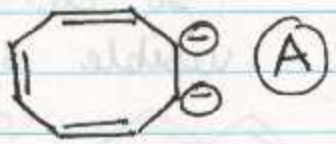
Annulene [10]

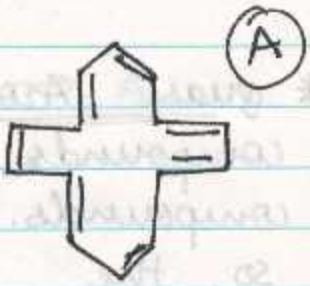
{ overlapping b/w the orbitals will be restricted due to rotation as a result of H-H interaction }



Annulene [12]

{ Does not attain planarity. Prefers being non-planar but not A A }





Annulene [14]

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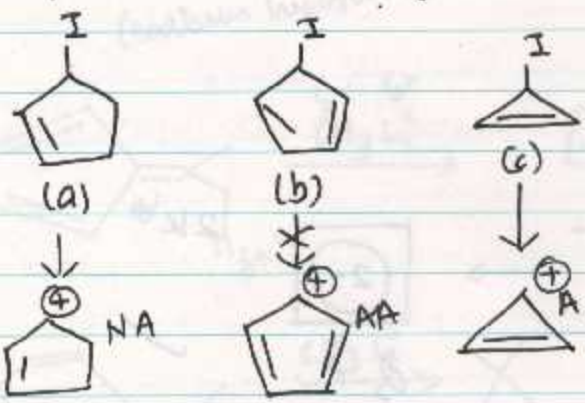
* Reactions related to Aromaticity :-

Q. compare rate of abstraction of I^- :-

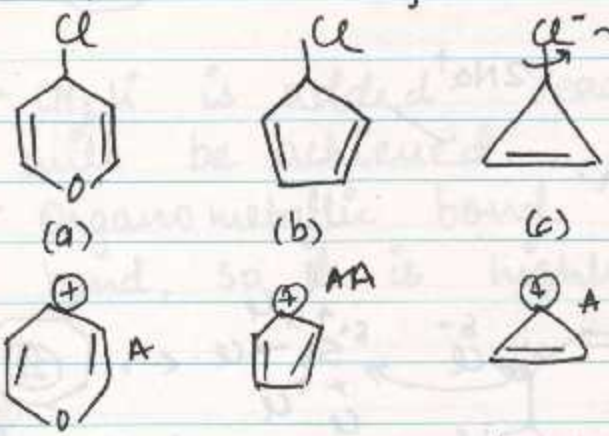
i a)



c > a > b

Q. compare rate of rean with $AgNO_3$:→

2)

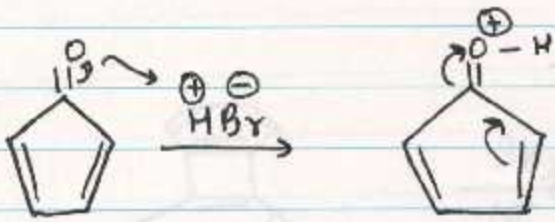


6 > 5 > 7 > 4

a > c > b

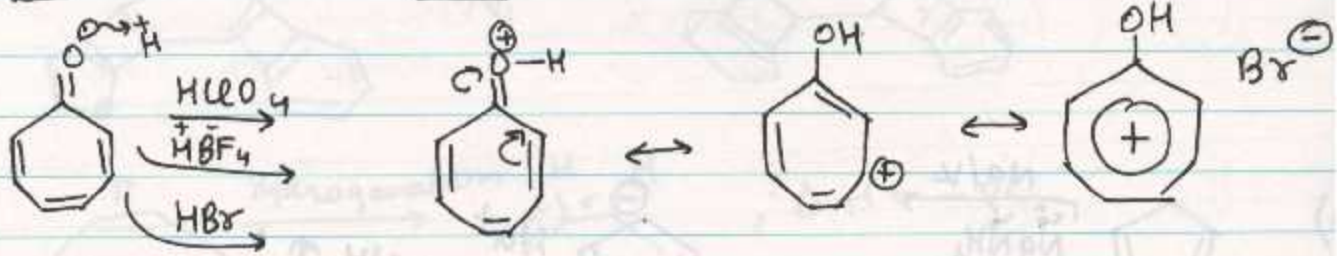
Rate ∝ Stability of c^+

3)



∝ AA.

4)



HBF_4 → Fluoro boric acid ($HF + BF_3$)

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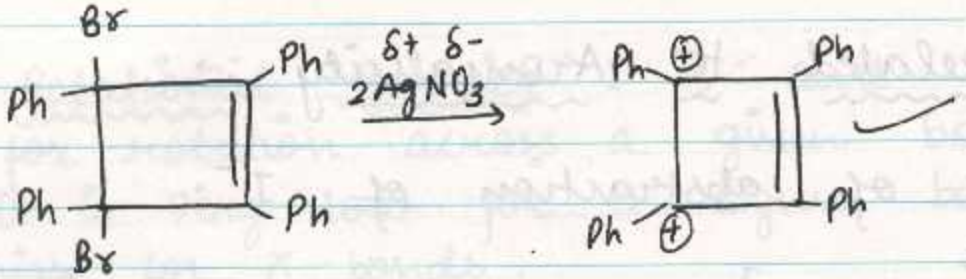
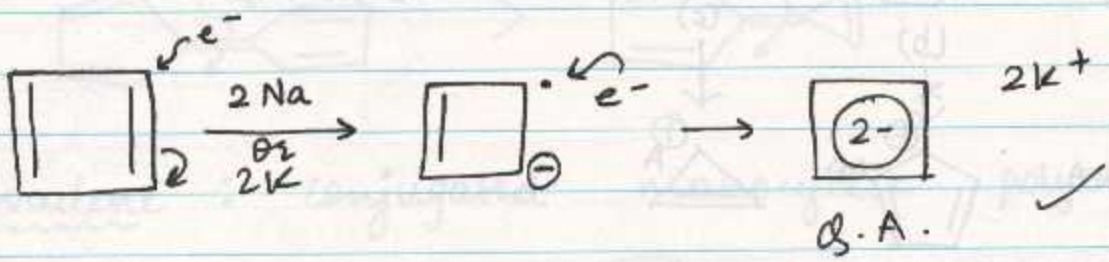
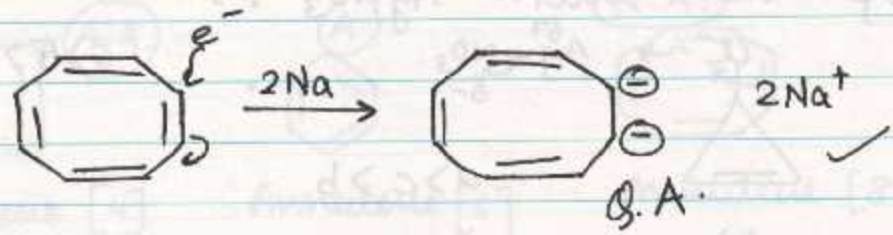
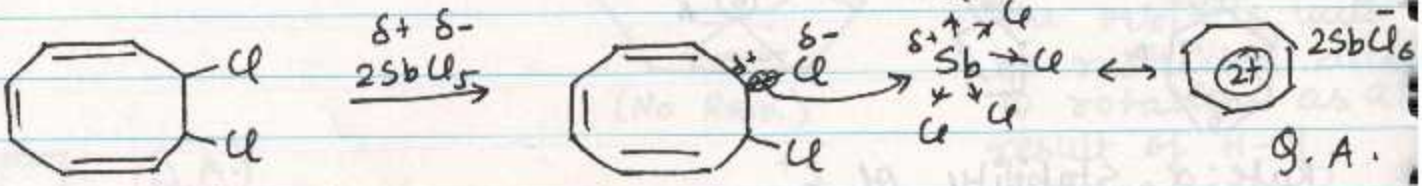
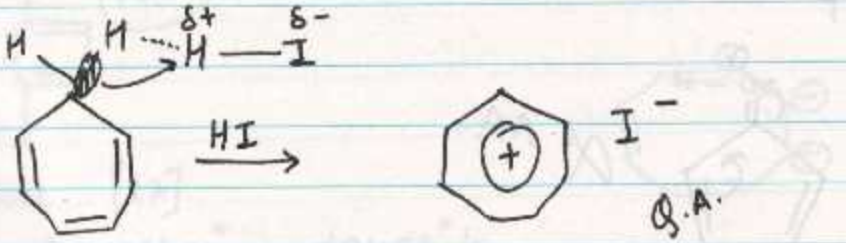
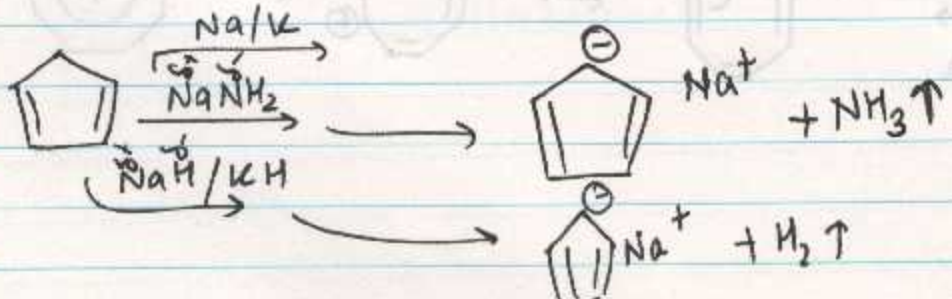
5) 

6) 

7) 

8) 

9) 

10) 

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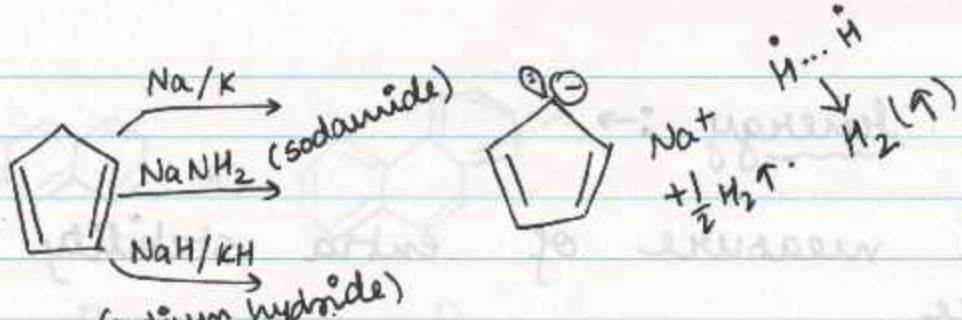
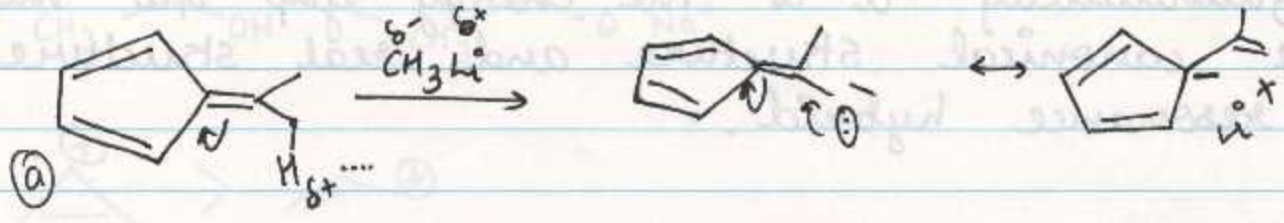
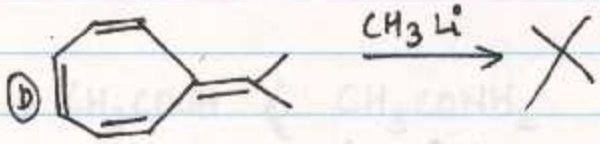
11)



12)



ⓐ



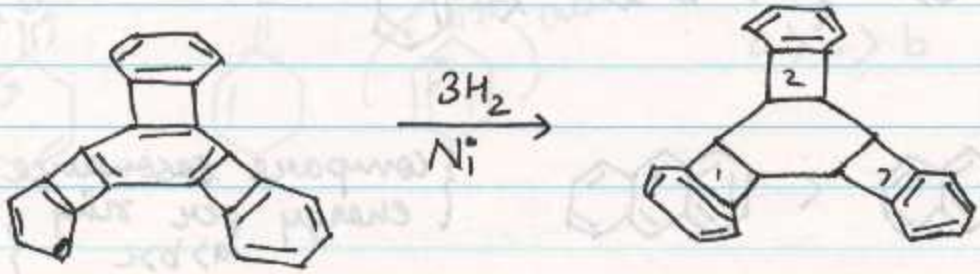
ⓑ

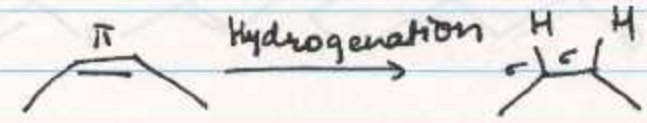
- CH_3Li is added readily to ⓐ coz aromaticity will be achieved.
- Organometallic bond is highly polar covalent bond, so it is highly reactive e^- donor.

H.W.

DPP # 22 (10X)

Q.





$\therefore \Delta H = -ve$

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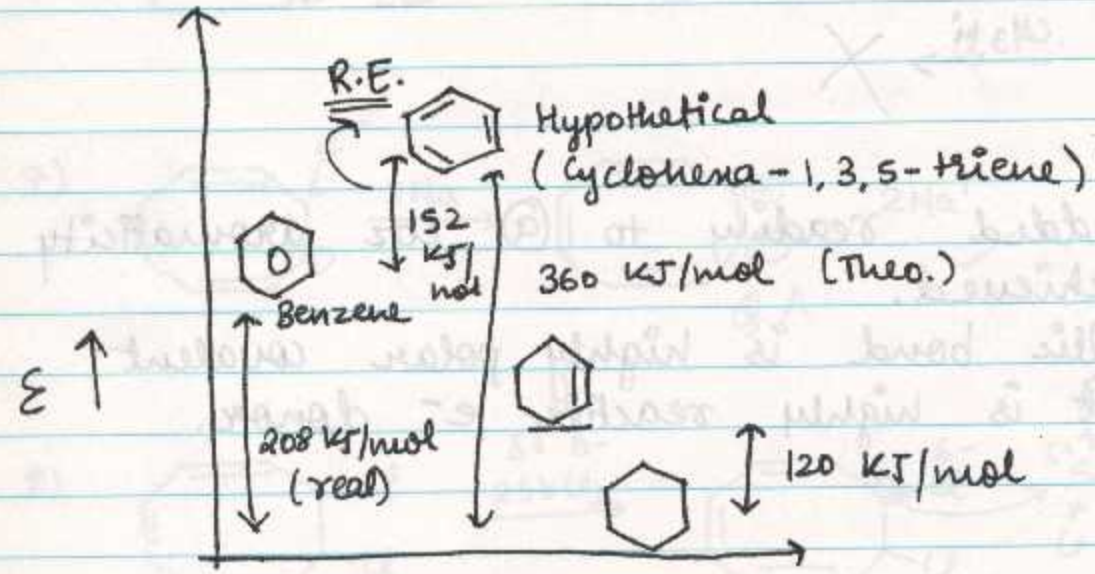
* Resonance Energy :→

It is a measure of extra stability due to resonance.

Quantitatively it is the energy gap b/w most stable canonical structure and real structure i.e. resonance hybrid.



Q.

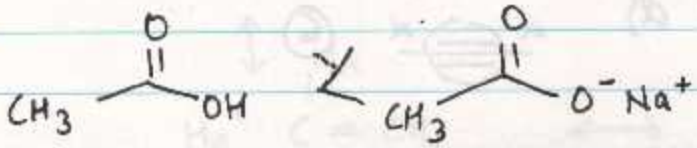
a) = < < <

b) < < {compare resonance energy per ring a>b>c}

c) > N

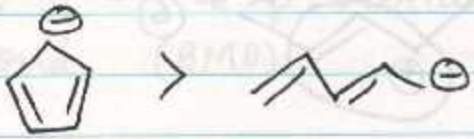
d) N > O < S c > a > b

e)

f) 

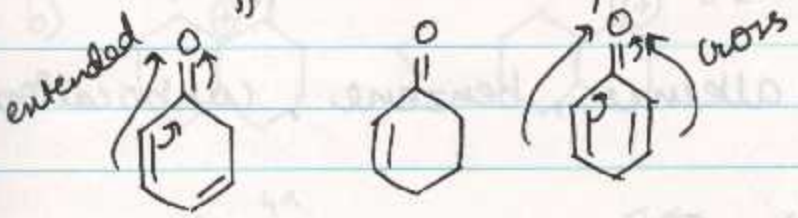
g)

h) CH_3COOH < CH_3CONH_2

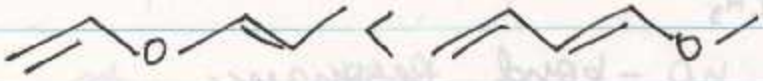
i) 

j)

• Intended Resonance is better than cross coz of more effective overlap.



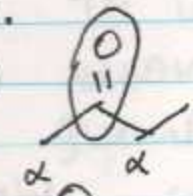
a > c > b



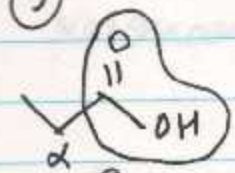
b > a

- α-hydrogen :→ C-atom directly attached to FG is α-C & hydrogens on it are α-hydrogens.

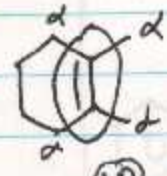
Q.

a) 

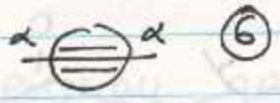
(5)

b) 

(2)

c) 

(10)

d) 

(6)

e)

(5)

f)

(2)

g)

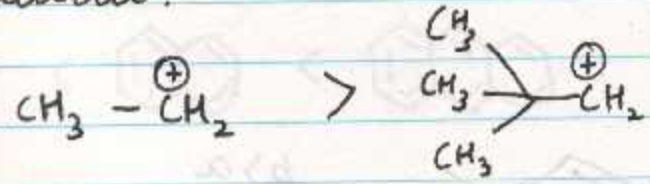
(6)

h)

(7)

* Hyperconjugation :→ (Baker - Nathan Effect)

It is possible in alkenes, benzene, carbocation, free radical.



σ (filled) – p (empty) conjugation / NO-bond Resonance

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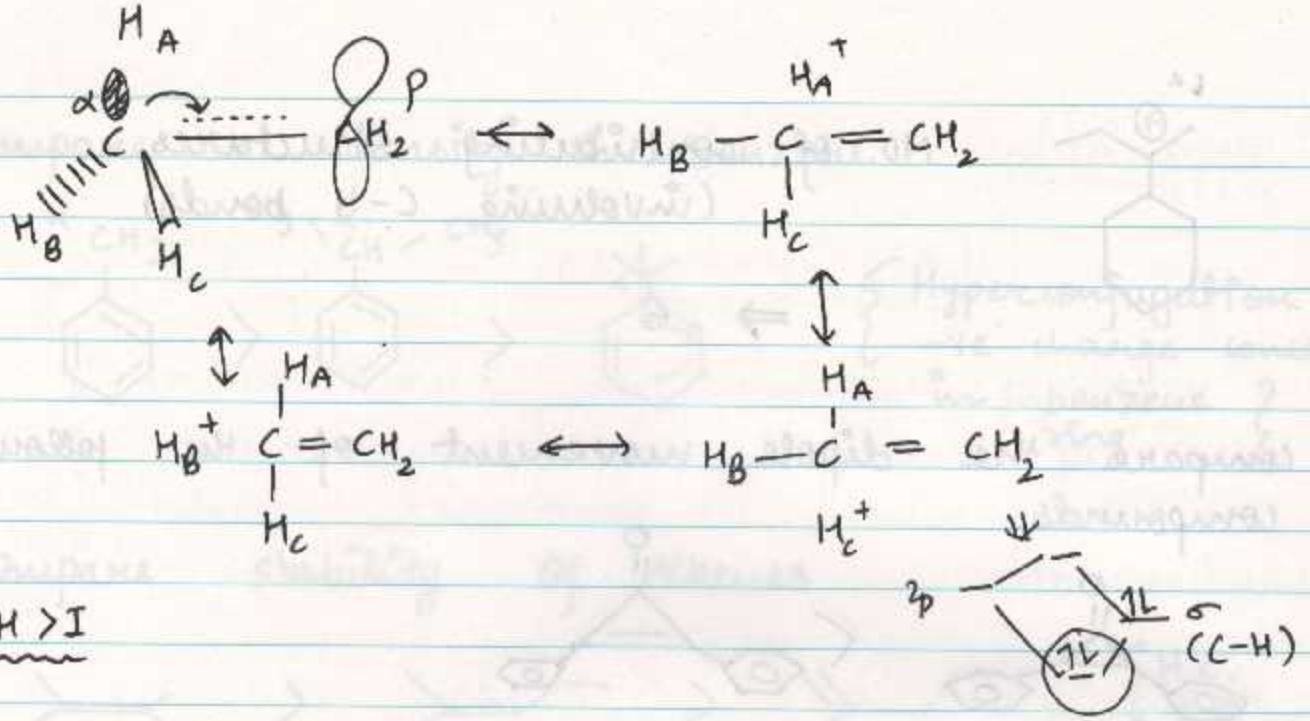
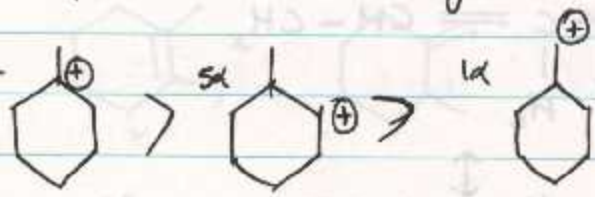
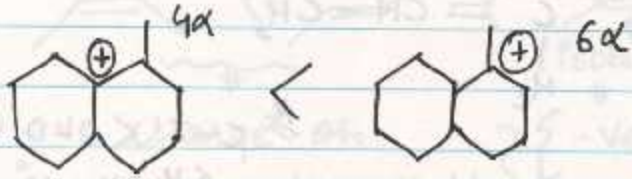


** • R > H > I

- Here, stability occurs due to constructive overlap b/w σ & p-orbital, forming low energy bond (BMO).

Q. Compare stability :

a) 

b) 

c)

d)

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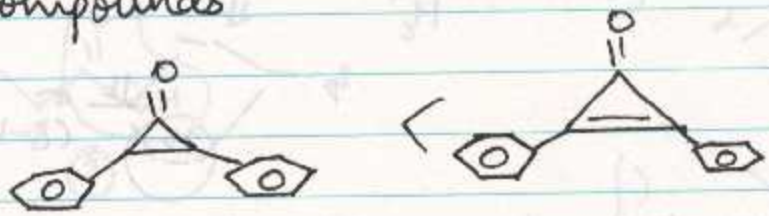
Q.

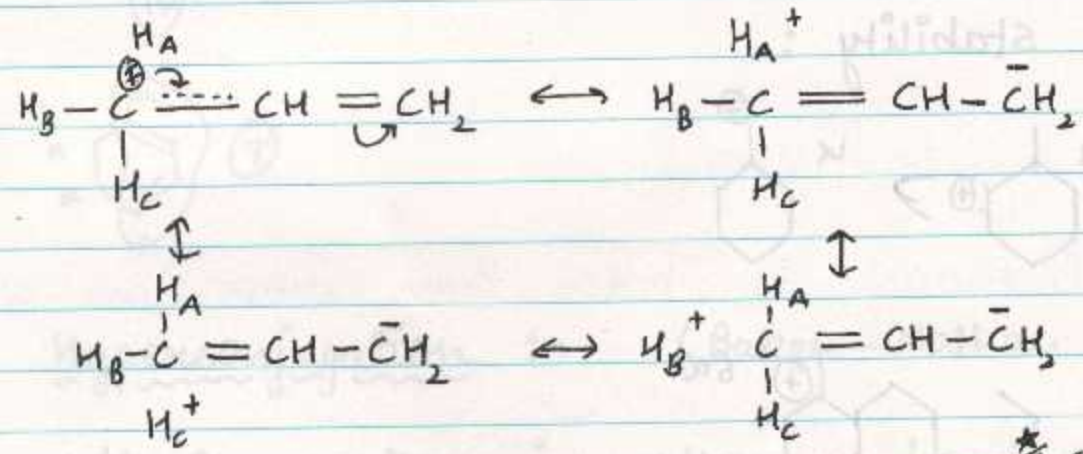
No. of contributing structures (involving C-H bonds)

$\Rightarrow$ 6

Q. Compare the dipole movement of the following compounds

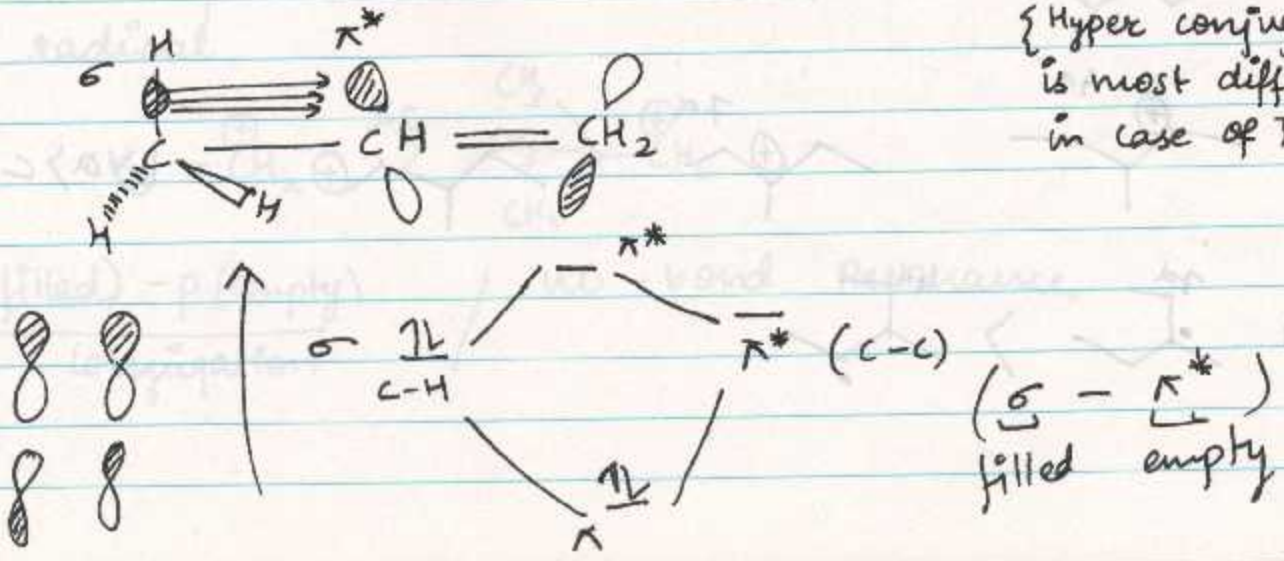


* Hyperconjugation in Alkenes :→



* C-T < C-D < C-H
{Hyper conjugation is most difficult in case of Tritium}

Ans.



(σ - π^*) filled empty

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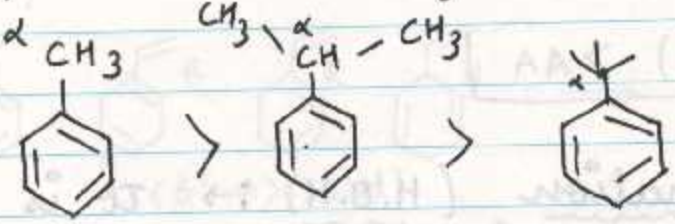
Q. Compare e^- density in benzene



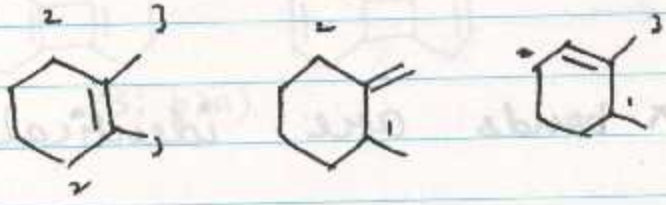
{ Hyperconjugation -ve charge con in benzene ring }

Q. Compare stability of Alkenes

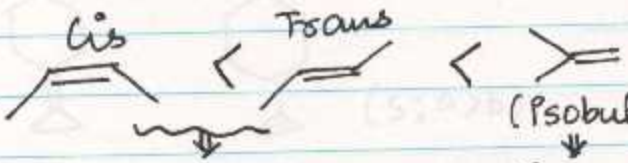
a)

{ H.C. α-H more

- Stability can be experimentally measured usi heat of combustion data

b) 

a > c > b

c) 

c > b > a

{ -ve charge on 2° C hence less stable } { -ve charge on 1° C hence more stable }

* Applications of RHI :→

$$|A > (RHI) > AA|$$

→ Heat of Hydrogenation (H.O.H) :→ It is amt. of energy released per mole of the substance when it undergoes complete hydrogenation.

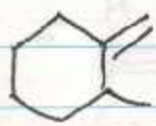
**. H.O.H $\propto$ no. of π-bonds.

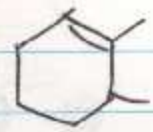
$$CH_2 = CH_2 \xrightarrow[Ni]{H_2} \overset{H}{\underset{|}{CH_2}} - \overset{H}{\underset{|}{CH_2}}$$

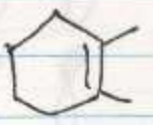
$x - y \rightarrow$ -ve (-z kJ/mol) → H.O.H.

**. In case no. of π-bonds are identical check stability

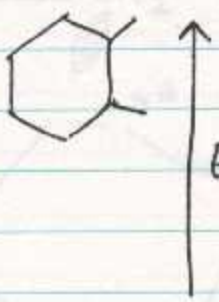
$$HOH \propto \frac{1}{\text{Stability}}$$

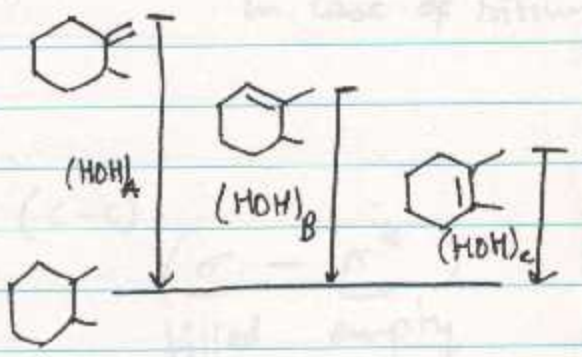
eg, a)  $\xrightarrow[Ni]{H_2}$

b)  $\xrightarrow["]{"}$

c)  $\xrightarrow{"}$

Stability ⇒ c > b > a





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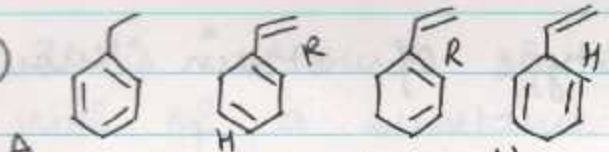
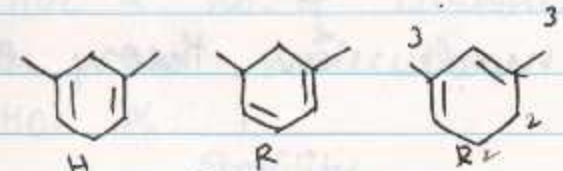
Q. Compare H.O.H.

a) 

→ d > b > c > a.

(S: a > c > b > d)

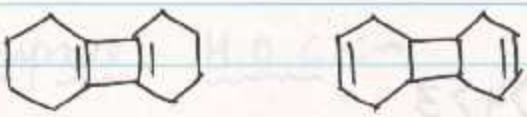
b) 

→ a > b > c

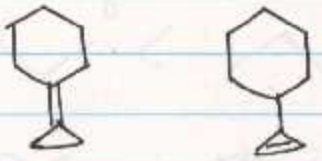
(S: c > b > a)

c)
→ a > b > c

(S: c > b > a)

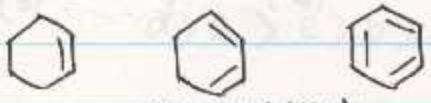
d) 
→ a > b

(S: b > a)

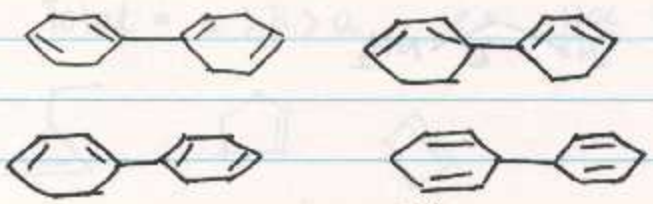
e) 
→ b > a

(S: a > b)

* f) M-based!


→ b > c > a

(S: a > b > c)

g) 

→ d > c > b > a

(S: a > b > c > d)

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* Baeyer's Angle Strain Theory :→

- Baeyer introduced a new type of strain known as angle strain.
- It occurs due to difference b/w actual angle & desired angle.
- A false assumption was made in theory that rings are planar.

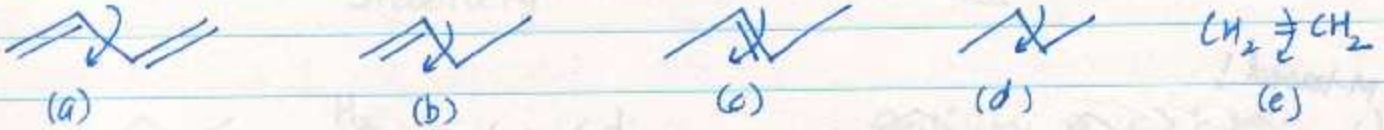
Baeyer's proposed order,

5 > 6 > 4 > 3 ☹

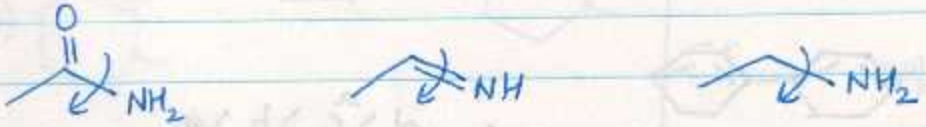
Actual order,

6 > 5 > 4 > 3 ═ 6 > 5 > 7 > 4 > 3

Q. Compare rotational barrier across the given bonds :

1) 

→ e > c > a > b > d

2) 

→ c < a < b

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* Heat of Combustion (H.O.C) :→

- It is amount of energy released when 1 mol of a substance is burned in presence of oxygen completely.
- HOC ∝ no. of carbon

In case molecular formula is same,

$HOC \propto \frac{1}{\text{Stability}}$

$$C_xH_y + \left(x+\frac{y}{4}\right)O_2 \xrightarrow{\Delta} x\,CO_2 + \frac{y}{2}H_2O$$

$$\Delta H = -Z \text{ KJ/mol}$$

Q. compare H.O.C :→

1) $> CH_2=CH_2$

2)

3)

d > a > e > b > c

4)

Total = c > b > a ; $\frac{HOC}{CH_2}$ = a > b > c (angle strain)

5)

c < b < a (angle strain)

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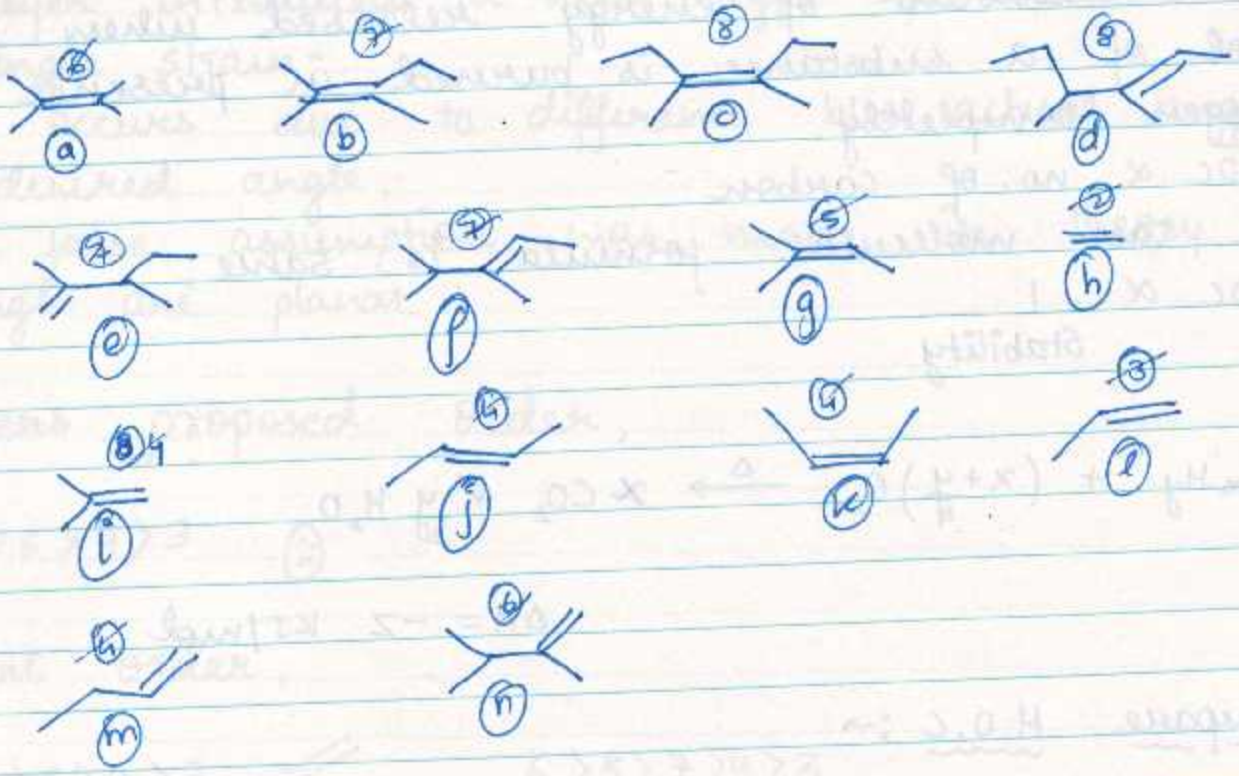
6) c > a > b

7) 

→ h < l < i < j < k < m < g < a < n < b < f < e < c < d

8)

→ ~~d > a~~ c < d < b < a

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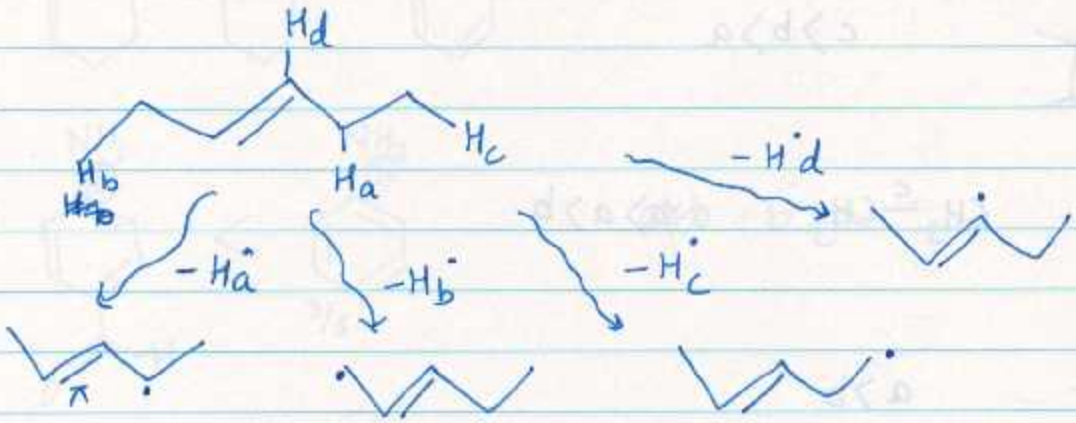
* Bond energy comparison :→

- Break the C-H bonds homolytically & compare the stability of free radical.
- Stable the radical, it means that it is easy to form it so lower energy is needed.

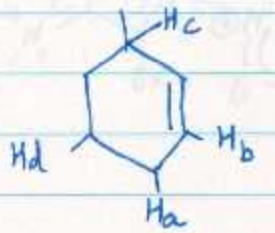


Stability :→ a > b > c > d

BE :→ d > c > b > a

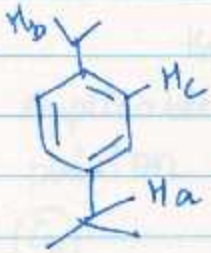
Q. Compare B.E. :→

1)



BE = b > d > a < c

2)



BE = c > b > a

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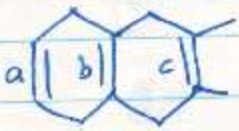
* Bond length comparison :→

- B.L. $\propto \frac{1}{\text{es}^- \text{ density}}$

Q. Compare B.L. :→

1) 

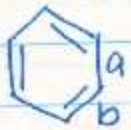
c > b > a

2)

$CH_3 \overset{c}{=} CH_3$ c > a > b

3)

a > b

4) 

a = b

5)

b > a (due to 3 resonating structures)

6)

$CH_2 \overset{b}{=} NH$ $CH_3 \overset{c}{-} NH_2$

c > a > b

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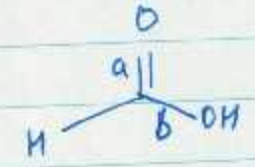
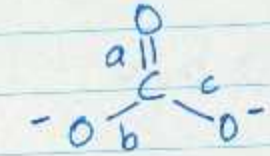
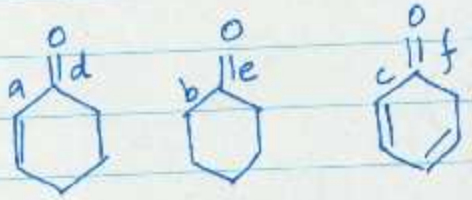
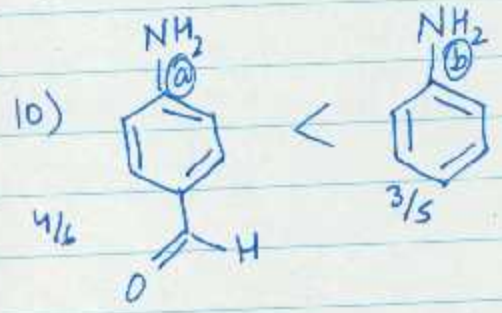
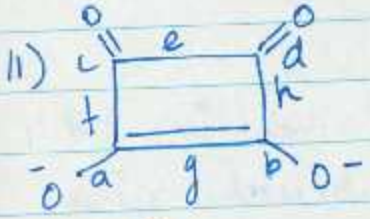
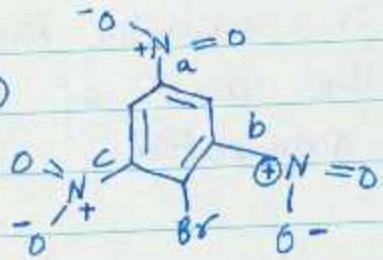
7)  b > a

8)  a = b = c

9)  b > a > c > d < f > e

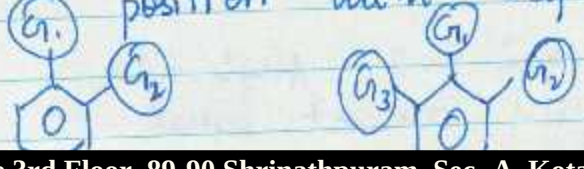
10)  b > a

11)  a = b = c = d ; c = f = g = h

12)  a < (b = c) { S.I.R Steric inhibition of resonance }

When due to steric repulsions a g rotates and as a result resonance is st then it is SIR effect.

Applicable when two grps are present on position with respect to each other (Bulky



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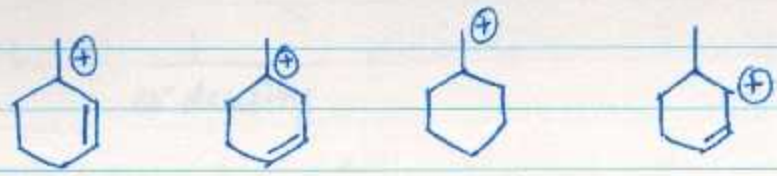
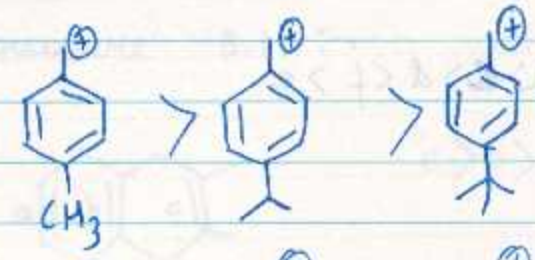
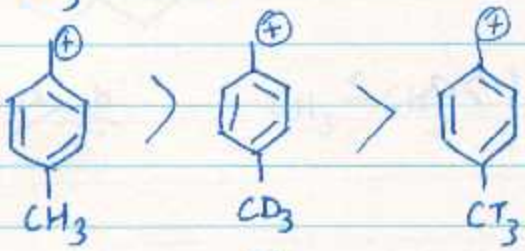
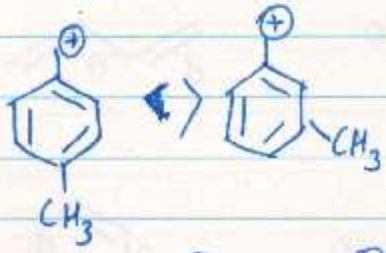
* Compare stability of C^+ / $C^\cdot$:→

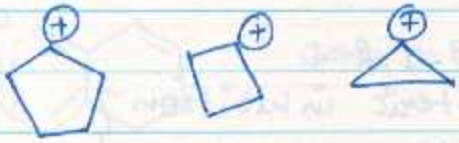
1)  a > d > b > c

2)  (α-H)

3) 

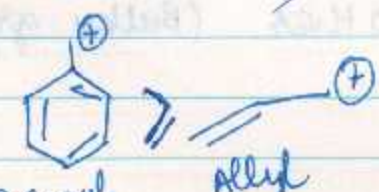
4) 

5) → a > c > b

6)  → a > b > c

7)

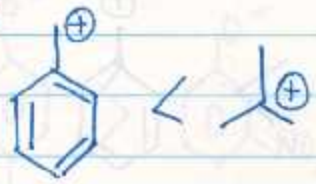
8)

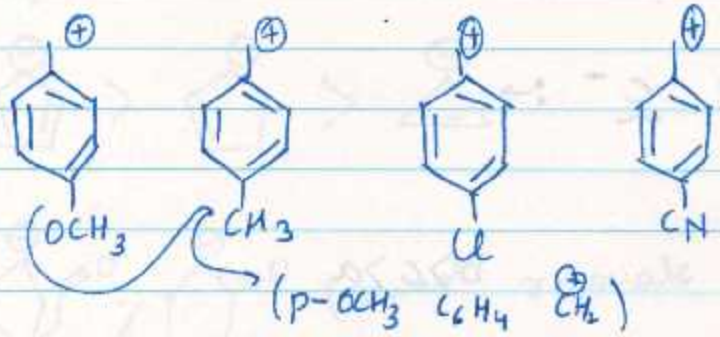
9) 
Benzyl Allyl

{due to equi. R.S. Allyl has stability almost equal to Benzyl }

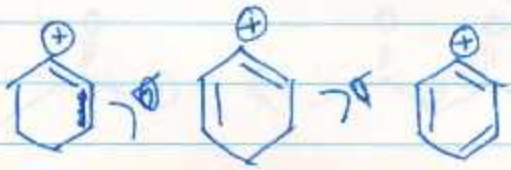
* sp^2 Hyb. in 3 & 4 membered ring is unstable except the cases of aromaticity

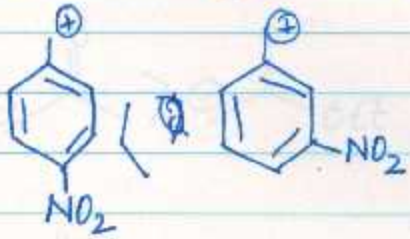
Exception

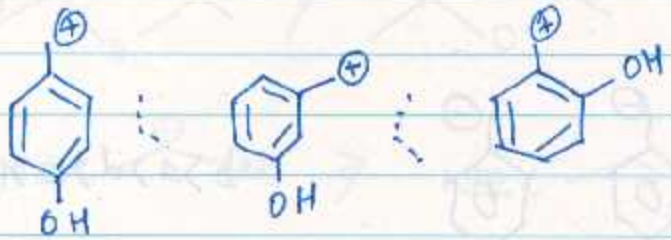
10) 

11) 

a > b > c > d

12) 

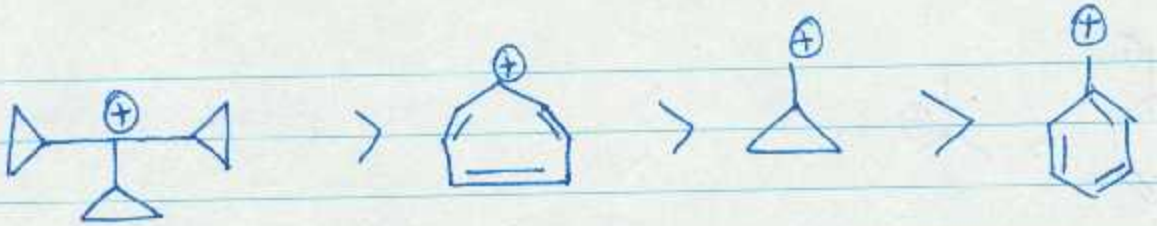
13) 

14) 

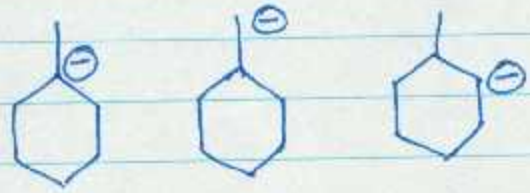
a > c > b

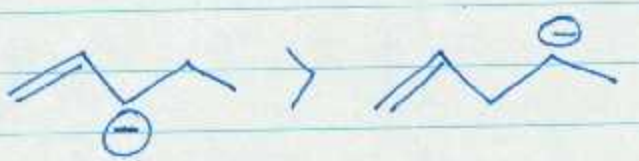
* Special stability of C.P.M. $C^{\oplus}$
cyclo propyl methyl

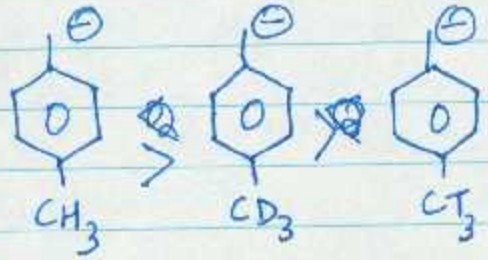
Dancing Resonance

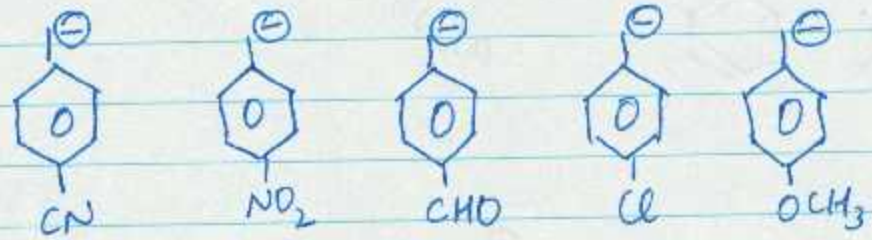
***
15) 

* Compare stability of C^- :→

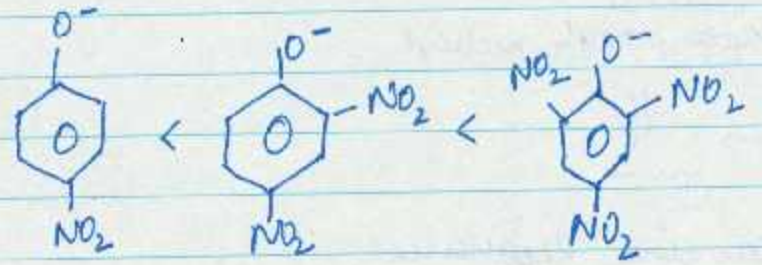
1)  b>c>a

2) 

3) 

4) 

b>a>d>c>e

5) 

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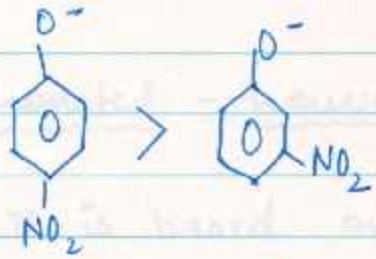
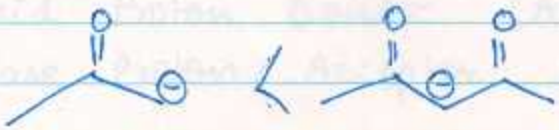
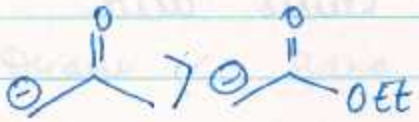
6) 

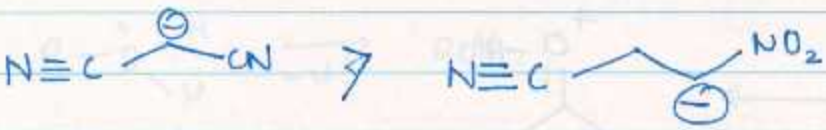
7)

8) (cannot resonate due to Bredt's rule)

9) 

10)  (availability of more e^- cloud)

11)

12) 

* If same halogen is moved from ortho, meta to para position then use inductive effect.

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* Theory of Acid / Bases :→

• Arrhenius

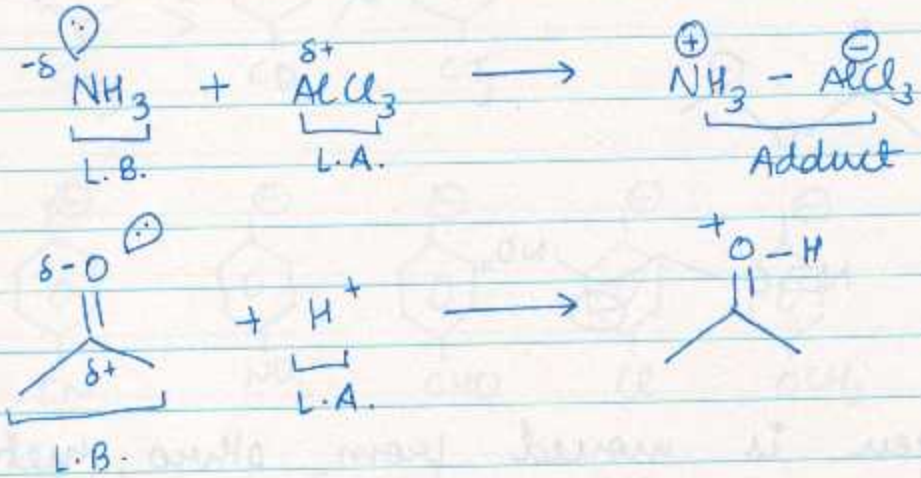
→ Acids donate H^+ & bases donate OH^-

HCl, HF, $HClO_4$, H_2SO_4 } Acids (donate H^+)

$NaOH$, KOH, $Mg(OH)_2$, $Ca(OH)_2$ } Bases (donate OH^-)

• Lewis

→ Lewis base donates e^- pair ; Lewis acid accepts that e^- pair.



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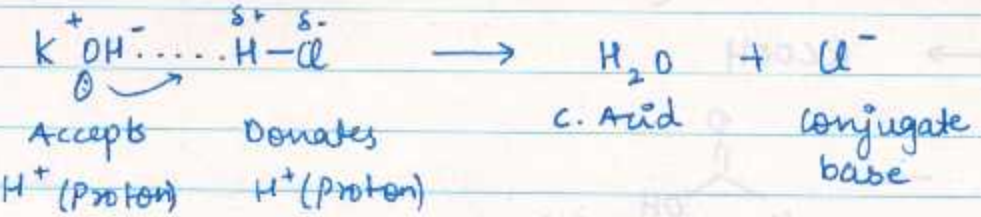
• Bronsted - lowry concept

→ It is based on the proton donation / acceptance



- Acid Proton Donor (APD) (HCl, Cl^-) CAB Pair
- Base Proton Acceptor (BPA) (OH^-, H_2O) CAB Pair

Q. Draw C. Base

i) $H-\ddot{O}-H \xrightarrow{-H^+} OH^-$

ii) $H_3O^+ \xrightarrow{-H^+} H_2O$

iii) $R-\overset{+}{O}(H)-H \xrightarrow{-H^+} ROH$

iv) $R-OH \xrightarrow{-H^+} RO^-$

v) $R-\overset{+}{N}H_3 \xrightarrow{-H^+} RNH_2$

★ Remove hydrogen which is attached to most EN atom

Q. Draw C. acid

i) $\bar{O}H \rightarrow H_2O$

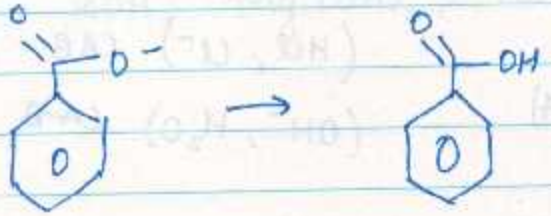
ii) $RO^- \rightarrow ROH$

iii) $RNH_2 \longrightarrow RH_3\overset{+}{N}$

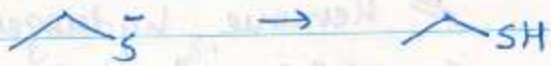
iv)

v) $RCOO^- \longrightarrow RCOOH$

vi)

vii) 

viii)

ix) 

- $\underline{K_a}$, $\underline{pK_a}$, $\underline{\text{acidic strength}}$:→

→ A strong acid is able to release more amt. of H^+ in the aq. sol^n

→ Acidic strength is a thermodynamic property.

$$\underbrace{H-A}_{\text{Acid}} + \underbrace{H_2O}_{\text{Base}} \overset{K_a}{\rightleftharpoons} \underbrace{H_3O^+}_{\text{C. Acid}} + \underbrace{A^-}_{\text{C. Base}}$$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

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$Ka_1 = 10^{-7} < Ka_2 = 10^{-5}$

$pKa_1 = -\log 10^{-7} > pKa_2 = -\log 10^{-5}$

$= 7 \qquad = 5$

So,

A.S. $\propto$ K_a $\propto \frac{1}{pKa}$ $\propto$ Stability of A^- (C. Base) $\propto$ E.W.G (-I, -m) $\propto \frac{1}{\text{E.D.G (+I, +m, +H}}$

Q. Compare A.S.

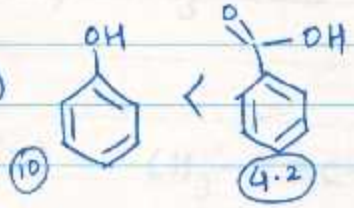
i) $CH_4 < NH_3 < H_2O < HF$ {Same Pd so EN}

ii) $HF < HCl < HBr < HI$ {diff Pd so size}

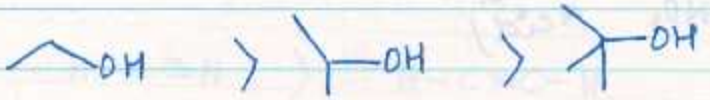
iii) CH_3OH CH_3SH CH_3NH_2

CH_3O^- CH_3S^- $CH_3\bar{N}H$

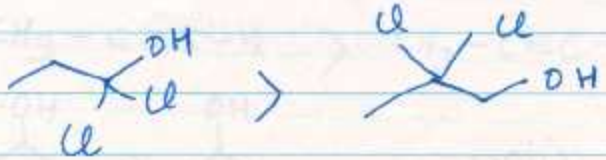
b > a > c

iv) 

{Resonance of -ve charge}

v) 

{E.D.G}

vi) 

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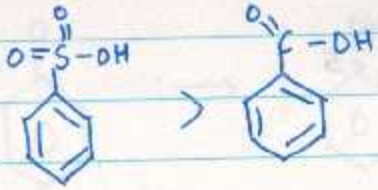
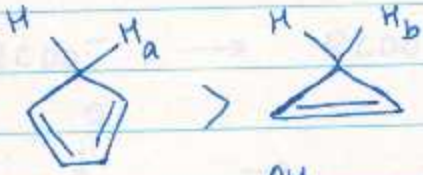
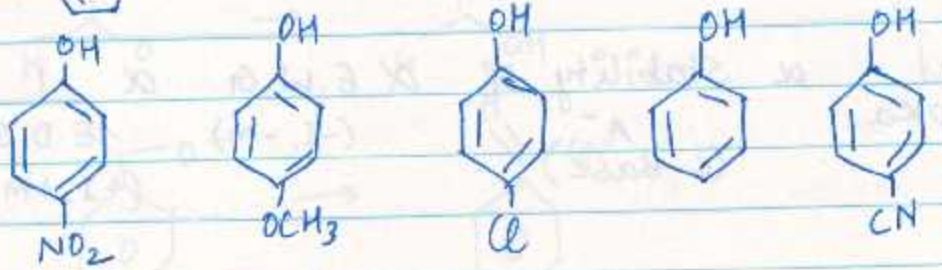
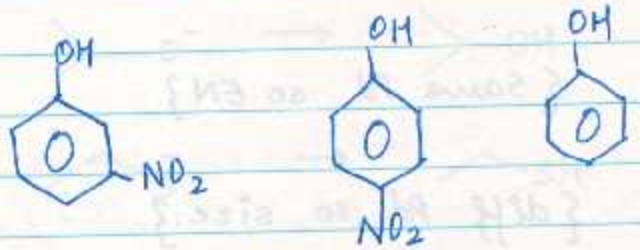
vii) $CCl_3OH < CF_3OH$

viii) 

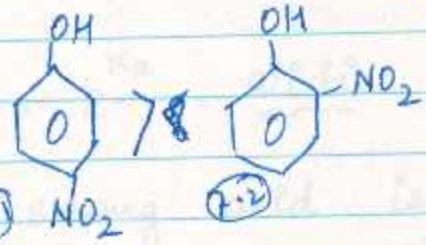
ix) 

x) 

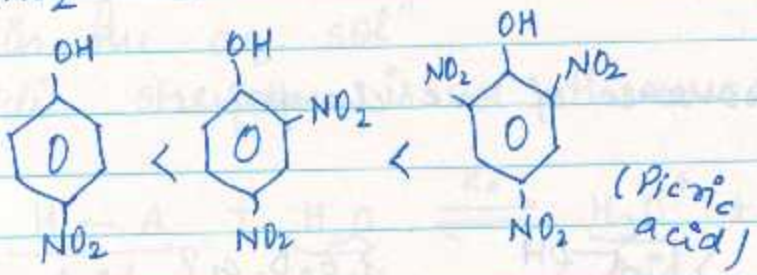
a > e > c > d > b

xi) 

b > a > c

xii) 

{due to H-bonding in o-NO_2 stabilised by π}

xiii) 

(Picric acid)

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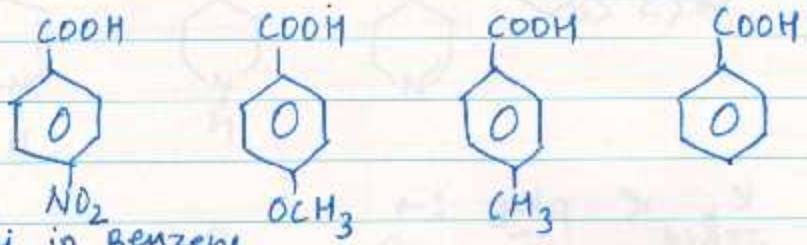
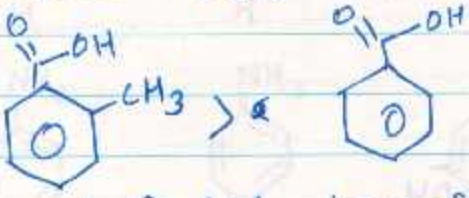
xiv)

* xv) 

(*-π conj. in Benzene & NO_2).

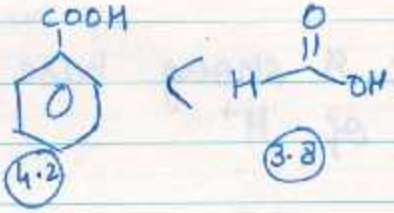
a > d > c > b

** xvi) Ortho Effect



{ ortho substituted benzoic acid is more acidic than benzoic acid }

→ Due to ortho sustitution & resultant repulsion, carboxylate ion moves out of the plane so resonan between benzene & carbonylate group is stopped resulting in more effective resonance within carbonylate ion.

xvii) 

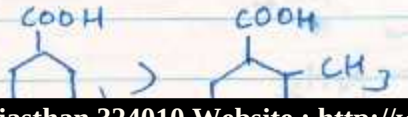
xviii) $\overset{(25)}{CH_3-C\equiv C-H} > \overset{(40)}{CH_2=CH_2} > \overset{(50)}{CH_4}$

xix) $CH_3-C\equiv C-H \lessdot CH_3-OH$ { Alcohols are more acidic than alkynes }

xx) $H-C\equiv N > H-C\equiv C-H$

* xxi) $CH_3-C\equiv C-H > CH_3-C\equiv C-CH_3$ { Terminal alkynes are more acidic than non-terminal alkynes }

xxii)

xxiii) 

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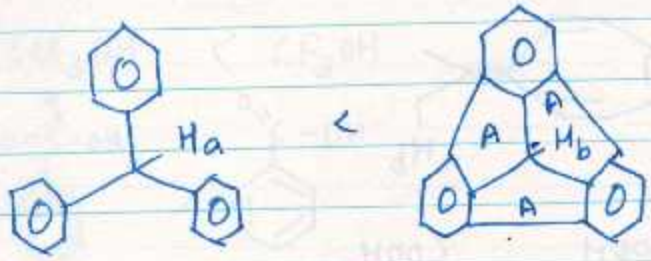
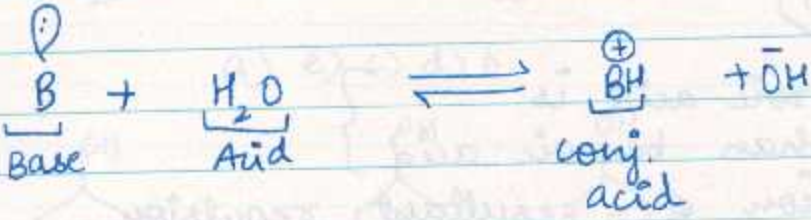
xxiv)



~~xxv~~

* Basic strength, K_b & pK_b :→

→ A strong base is able to accept more quantity of H^+



$$K_b = \frac{[BH^+][OH^-]}{[B]}$$

B.S. $\propto K_b \propto \frac{1}{pK_b} \propto$ stability of C. Acid $\propto$ EDG $\propto \frac{1}{EWG}$

Q. Compare B.S.

i)

{ Availaibility of l.p. }

* Basis strength will depend on availability of l.p. on donor atom

ii)

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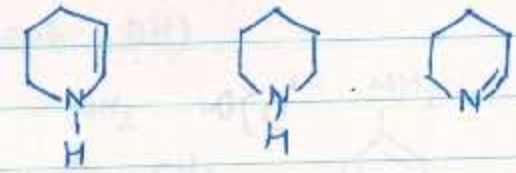
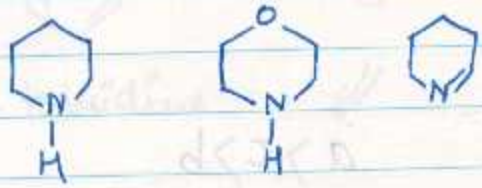
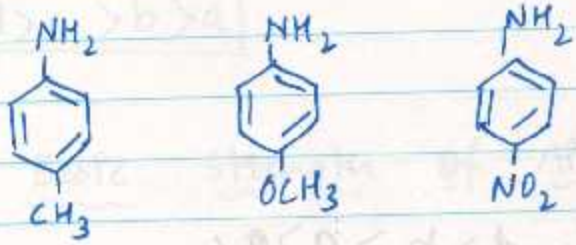
iii) $CH_3 - NH_2 > CH_2 = NH > H-C \equiv N$

iv)  b > c > a

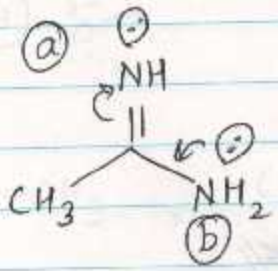
v)  b > a > c ~~×~~ a > b > c ✓

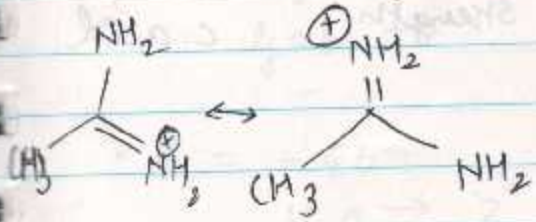
vi)  b > a > c

Q. Identify the site having more basic characte

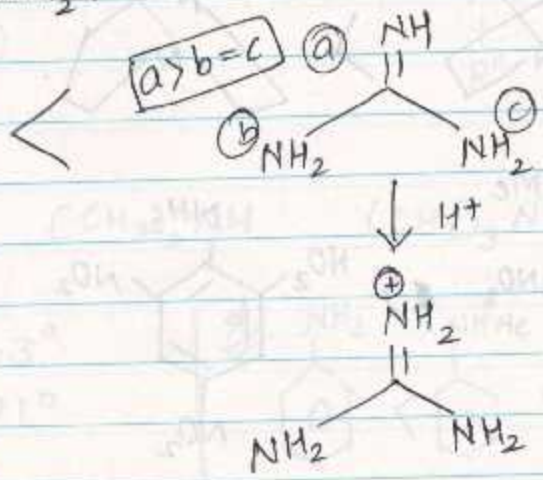
i) *// These bases are stronger than normal aliphatic amines such as RNH_2.

a >> b

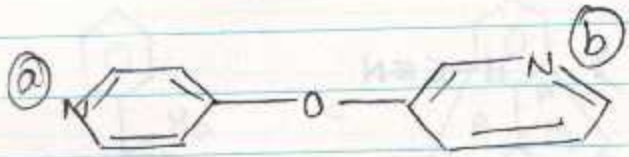




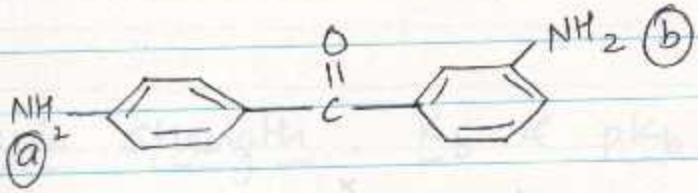
a > b = c



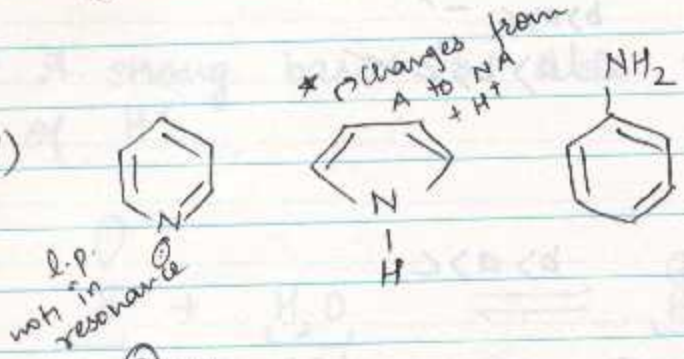
guani

ii) 

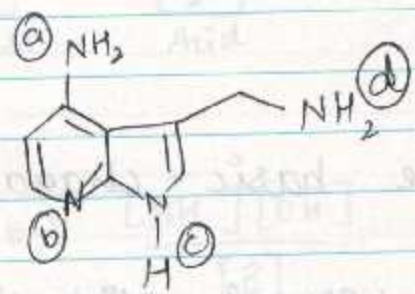
a > b

iii) 

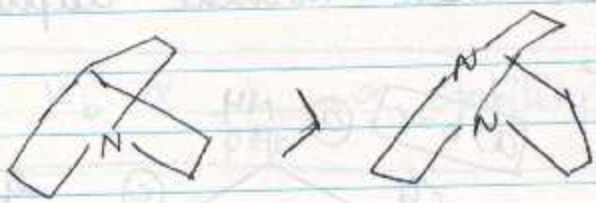
b > a

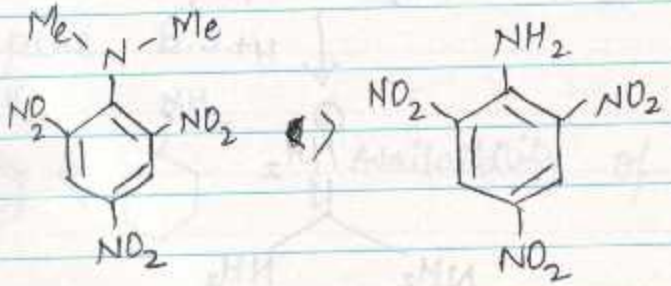
iv) 

a > c > b

v) 

d > b > a > c

vi) 

vii) 

*// Basic strength ∝ Pka of c. acid

S.I.R will ↑ basic strength

$\Delta pka = 4.6$

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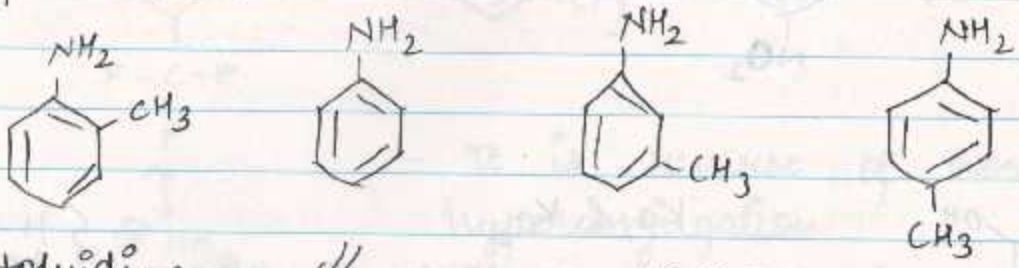
SIP Effect (Steric inhibition of Protonation)

- ortho substituted aniline is less basic than an (except OH).

★ viii)



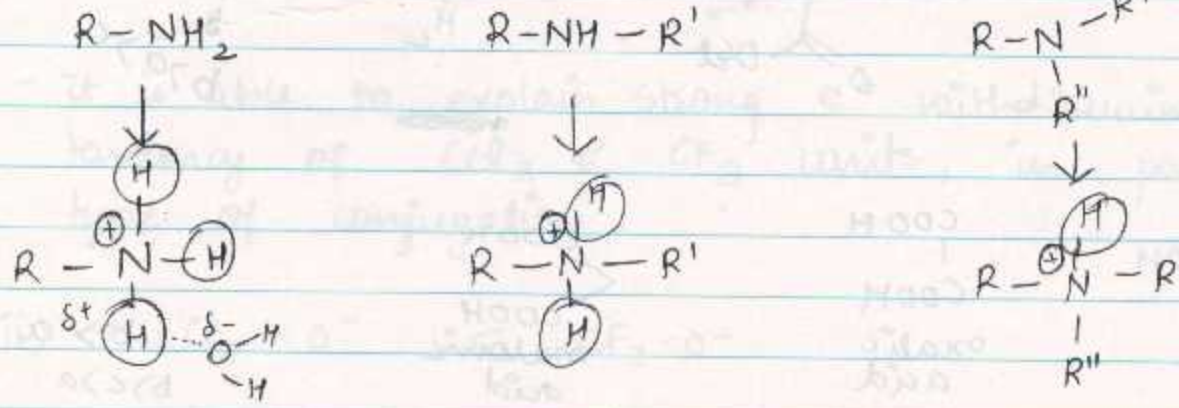
o-toluidine

$d > c > b > a$

$d > c$ { Hyperconjugation by $CH_3 \rightarrow H'$

★ NCERT **Basic strength of Aliphatic Amine :-**

ix)



- $R = -CH_3$, CH_3NH_2 $(CH_3)_2NH$ $(CH_3)_3N$

$H_2O \rightarrow 2^\circ > 1^\circ > 3^\circ$

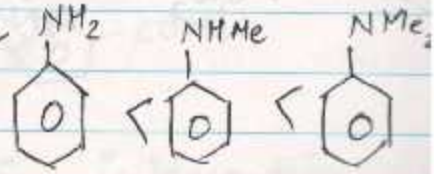
gas $\rightarrow 3^\circ > 2^\circ > 1^\circ$

- $R = -Et$

$H_2O \rightarrow 2^\circ > 3^\circ > 1^\circ$

gas $\rightarrow 3^\circ > 2^\circ > 1^\circ$

★



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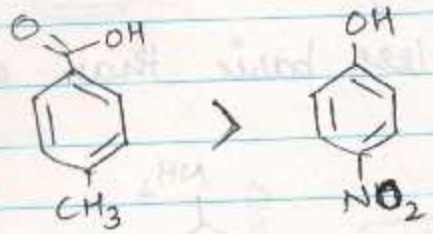
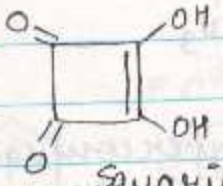
Q. compare acidic strength

i) 

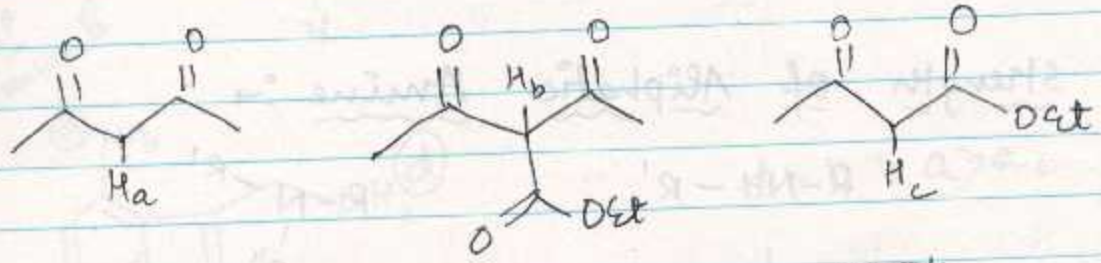
ii) 

Squaric acid

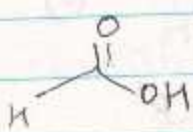
Ka_1 & Ka_2

$pKa_1 < pKa_2$ {H-bonding}

(1.5)

iii) 

b>a>c

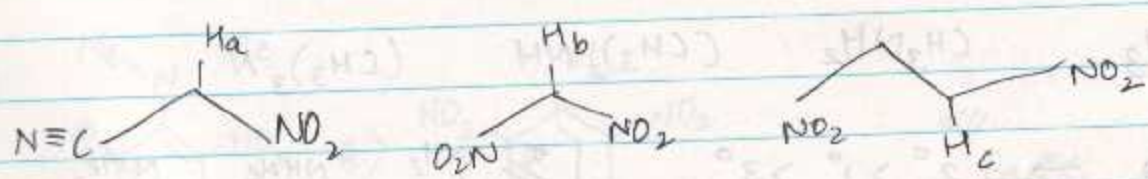
iv) 

COOH
|
COOH
oxalic acid

COOH
<
COOH
malonic acid

b > a

b>c>a.

v) 

b>a>c

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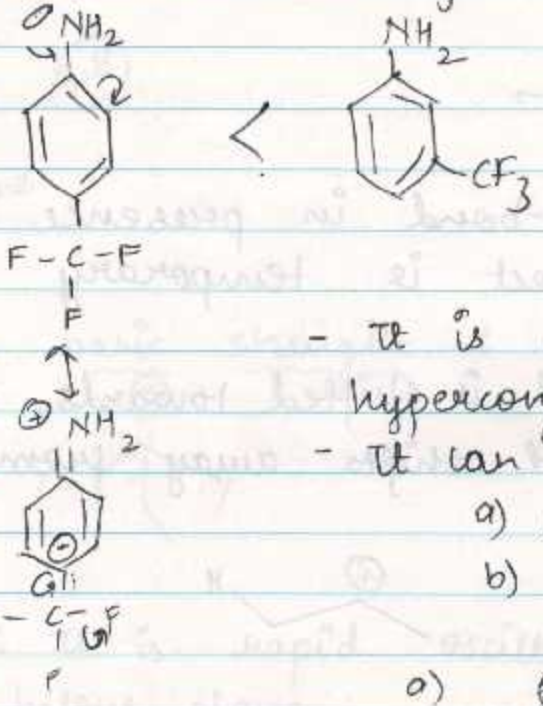
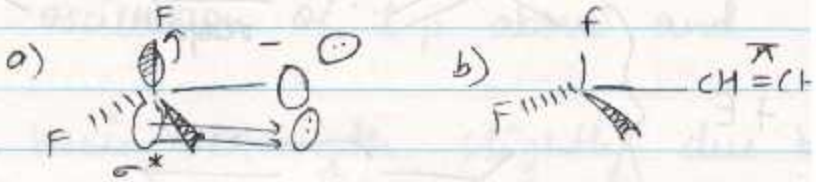
4* Q. compare basic strength (Reverse hyperconjugation

i) 

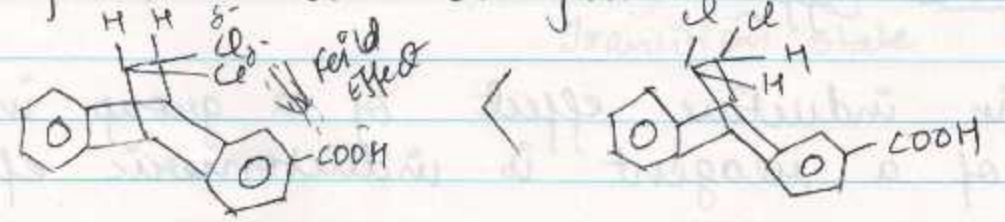
- It is reverse of normal hyperconjugation.
- It can be of two types :
  a) lp. - σ^* (empty)
  b) π - σ^* (empty)



- It is able to explain strong e^- withdrawing tendency of CCl_3 & CF_3 units, in particular type of conjugation.

ii) $CCl_3 - O^-$ < $CF_3 - O^-$

Q. Compare acidic strength

i) 

- Feild Effect :→ It is electrostatic interaction which operates thru space rather than bond.

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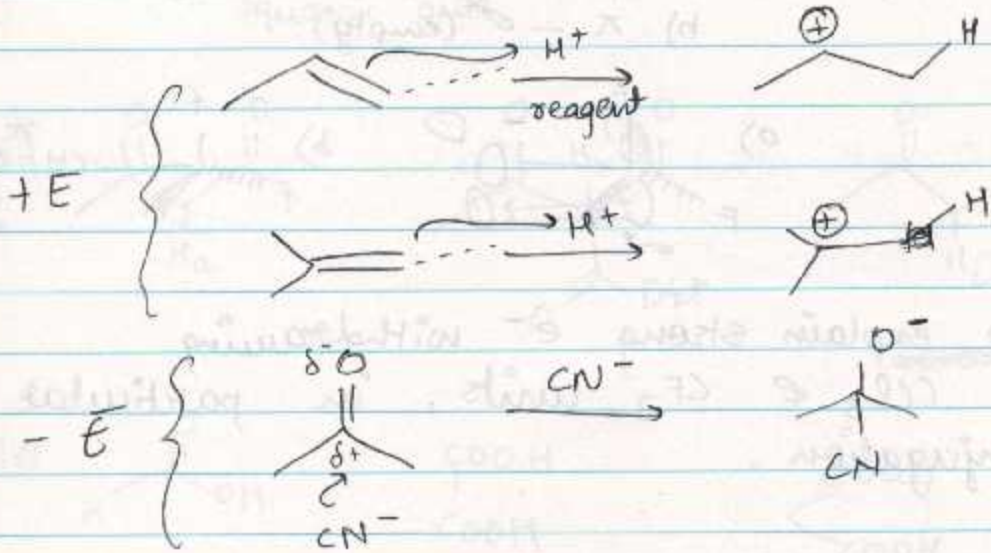
* Temporary Effects :→

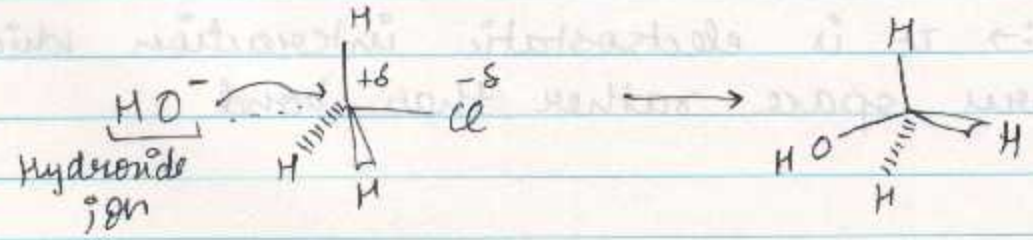
A.] Electromeric Effect :→

- It is shifting of π-bond in presence of a reagent. So this effect is temporary.
- It is of 2 types :→
  a) +E → when π bond is shifted towards reagent
  b) -E → when π bond shifts away from reagent



B.] Inductomeric Effect :→

- Increase in inductive effect of a group in presence of a reagent is inductomeric effect.



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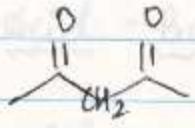
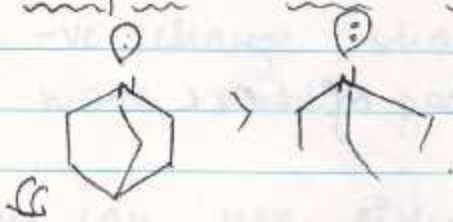


Active methylene

8-8

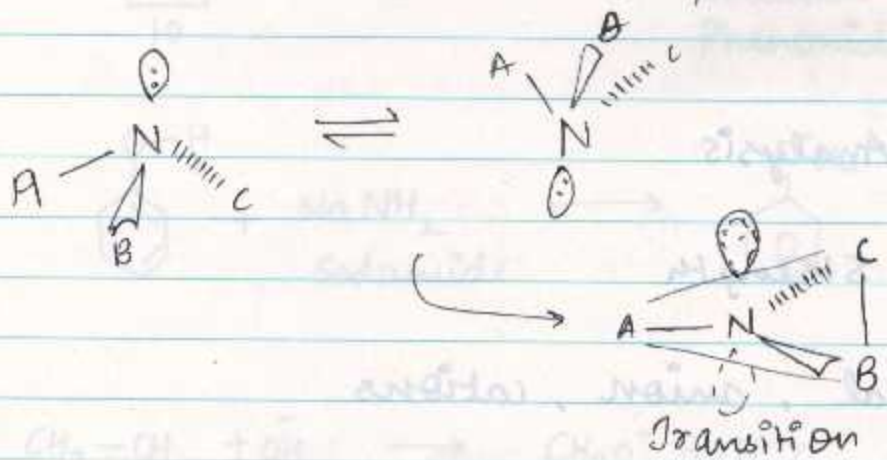
Q. compare basic strength :

i)



Flipping : It is rapid oscillation of l.p. above and below plane.

It decreases the basic strength slightly due to lesser availability of lone pair



Transition state

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* GOC - JEE Adv. Previous Papers Analysis

A.] Acidic Strength {Phenols & carboxylic acid}

- Basic Strength {Aliphatic & Aromatic amines}

- Resonanting structures & stability.

- Boiling point & Dipole moment of O.C.

- Aromaticity & related Rxns

- Acid - Base Rxns {NaOH, $NaHCO_3$}

- Hyperconjugation

GOC - JEE Mains Analysis

- Acidic & Basic Strength

- Stability of radical, anion, cations

- Aromaticity

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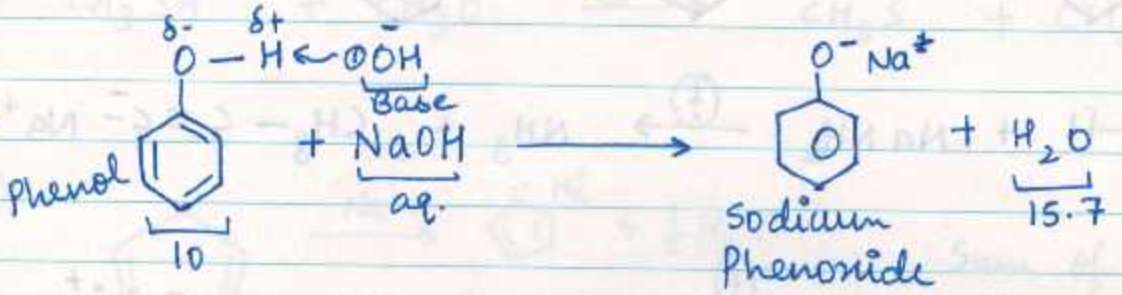
* Acid - Base Reactions in Organic Chemistry

• Condition for favourable Acid - Base Rxn :→

1. Pka value should increase by moving from left to right in the reaction.

2. -ve charge should move from less stable to more stable position.

You can use either of above conditions.

•


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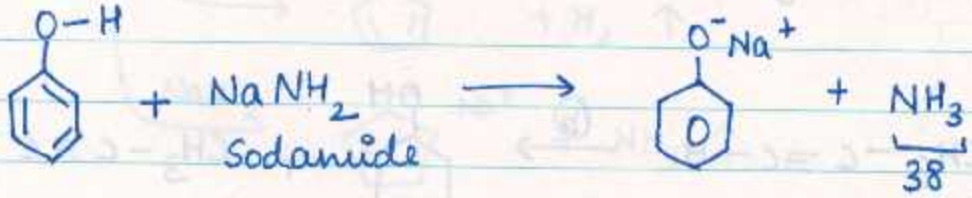

• $\underbrace{CH_3-OH}_{15.5} + \bar{O}H \longrightarrow CH_3O^- + \underbrace{H_2O}_{15.7}$ {Slightly favourable}

• $\underbrace{H-C\equiv C-H}_{25} + \bar{O}H \not\longrightarrow$ since $\underbrace{H_2O}_{15.7}$

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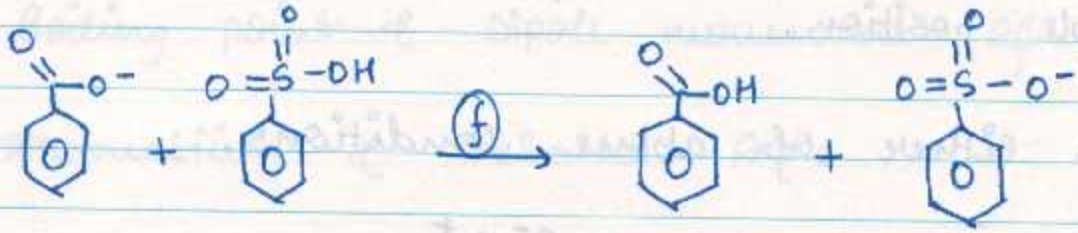
Q. Direction of equilibrium in Acid-Base rxn :

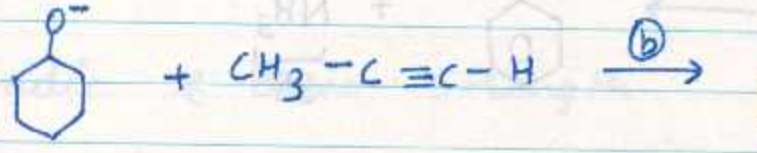
1)

2)

3) 

4) $CH_3-C\equiv C-H + NaNH_2 \xrightarrow{f} NH_3 + CH_3-C\equiv C^- Na^+$

5) $CH_3-C\equiv C-H + CH_3Li \xrightarrow{f} CH_4 + CH_3-C\equiv C^- Li^+$

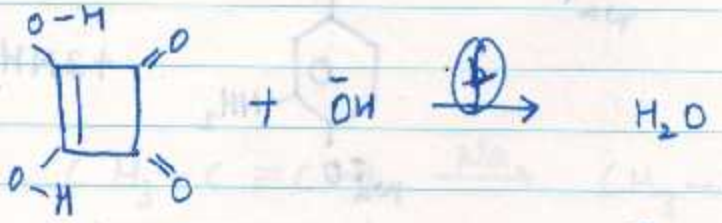
6) 

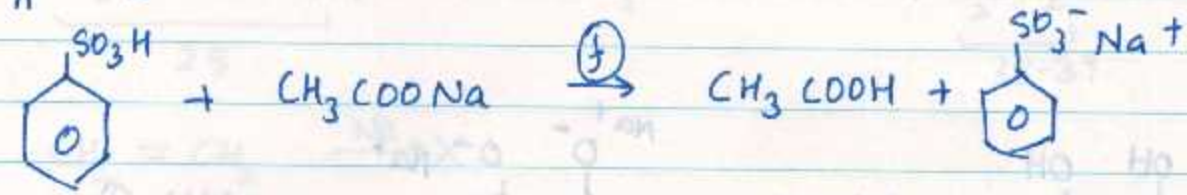
7) $OH^- + HCOOH \xrightarrow{f} H_2O + HCOO^-$

8) $\bar{O}H + NH_3 \xrightarrow{b} NH_2^- + H_2O$

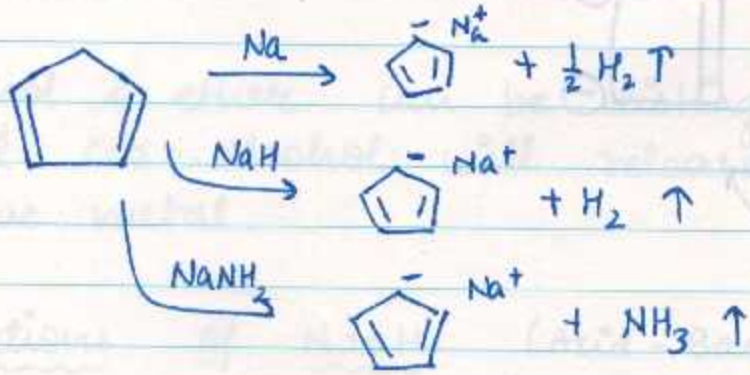
9) $NH_2^{\ominus} + H_2O \xrightarrow{f} NH_3 + OH^-$

10)

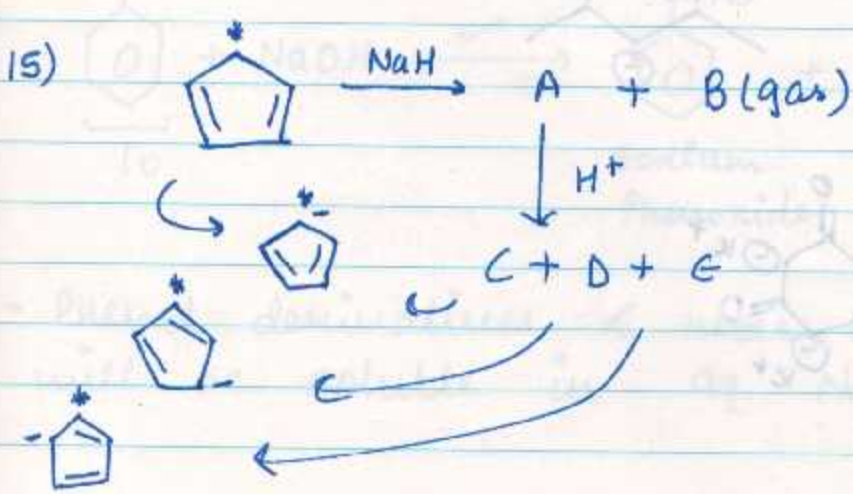
11) 

12) 

13) $CH_3SH + CH_3O^- \xrightarrow{f} CH_3S^- + CH_3OH$

14) 

Sum of MM of gases = 21

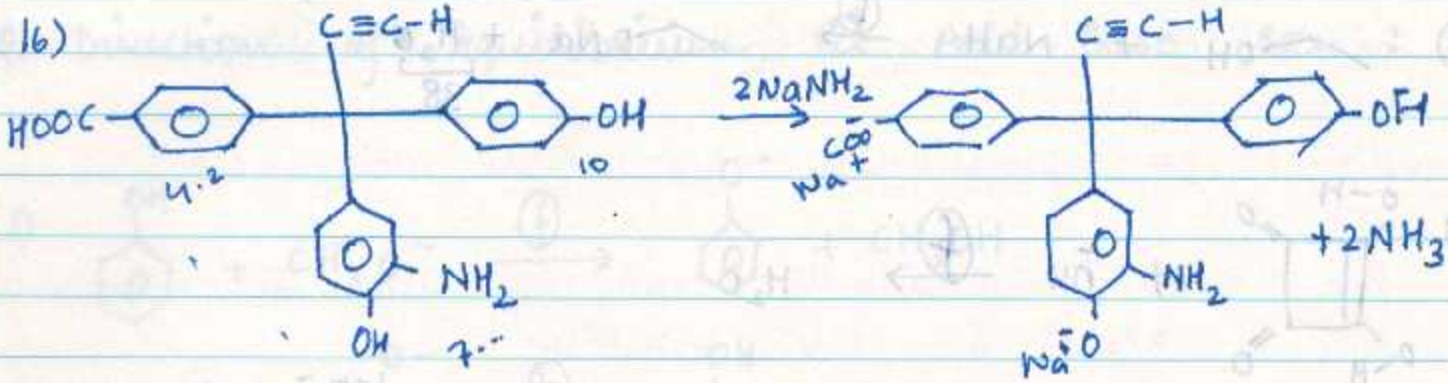
15) 

$C^* = C_{14}$

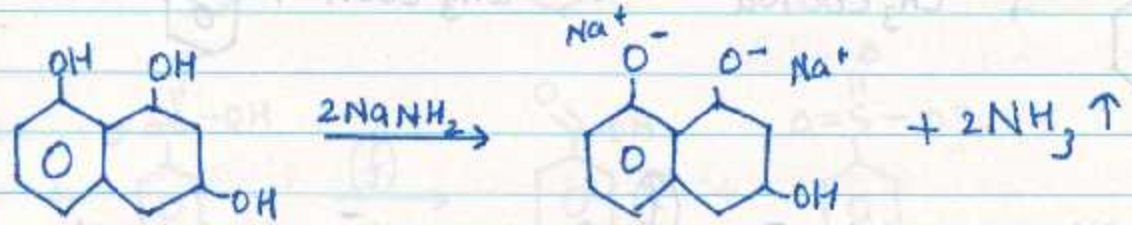
$B = H_2$

A =

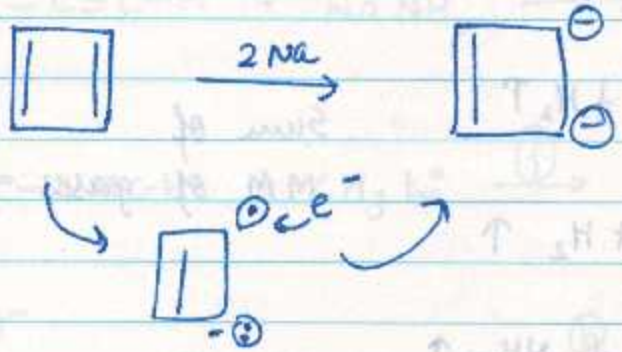
16)


C≡C–H
HOOC
OH
4.2
10
NH2
OH
7...
2NaNH2
COO⁻
Na⁺
C≡C–H
OH
NH2
Na⁺O
+2NH3

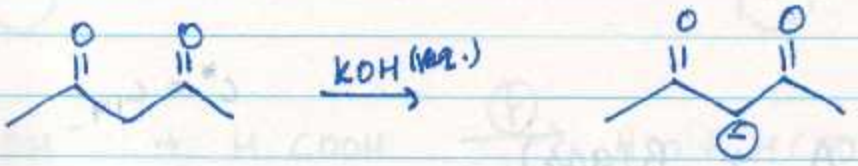
17)


OH
OH
OH
2NaNH2
Na⁺
O⁻
O⁻
Na⁺
OH
+ 2NH3 ↑

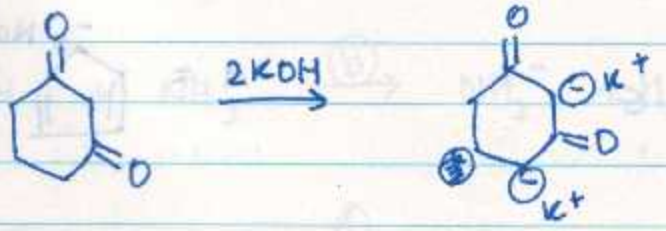
18)


2Na
e⁻

19)


KOH (aq.)

20)


2KOH
K⁺
K⁺

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* Reactions with strongest bases (Na, K, Al) active metals
(NaH / KH)
($NaNH_2$), CH_3Li / R-Li

21) $\underset{25}{CH_3-C\equiv C-H} \xrightarrow{Na} CH_3-C\equiv C^-Na^+ + \underset{38-39}{\frac{1}{2}H_2\uparrow}$

22) $CH_2=CH_2 \xrightarrow{Na} X$

23) $CH_4 \xrightarrow{Na} X$

**24)

alcohol ether

Alcohol & ether can be distinguished using 'Na' metal coz alcohol will release H_2 gas with active metal.

* Reactions of NaOH (Acid - Base)

- Phenol derivatives & more acidic compounds will be soluble in aq. NaOH.

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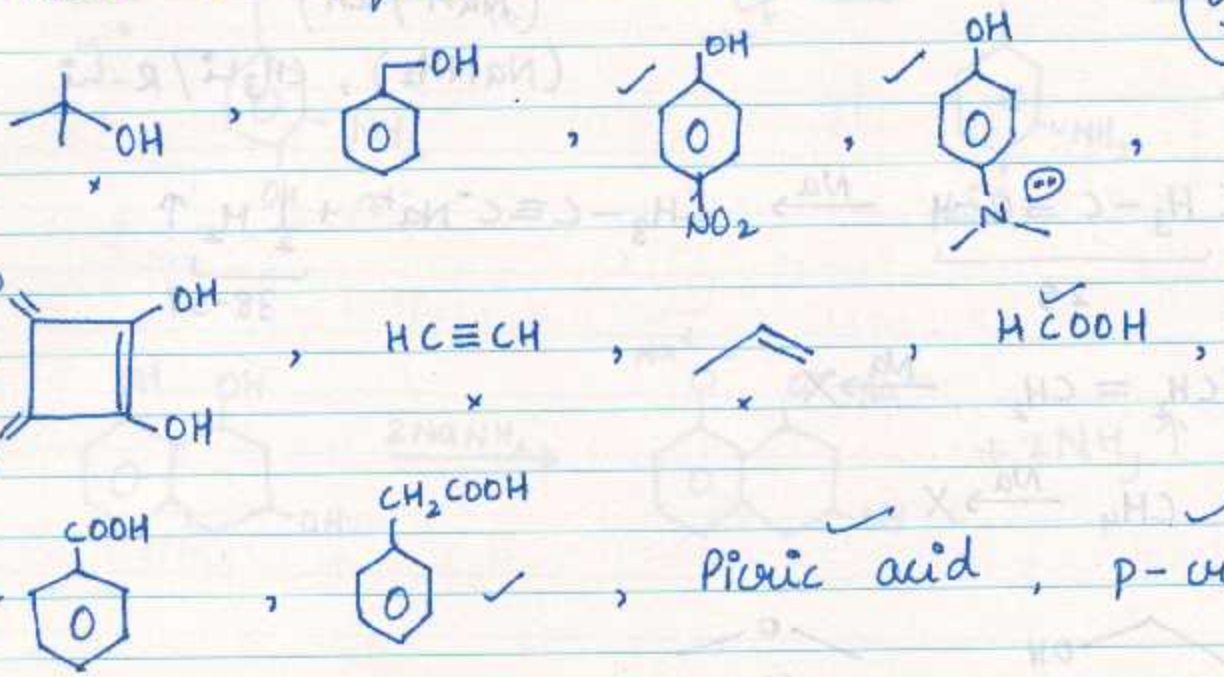
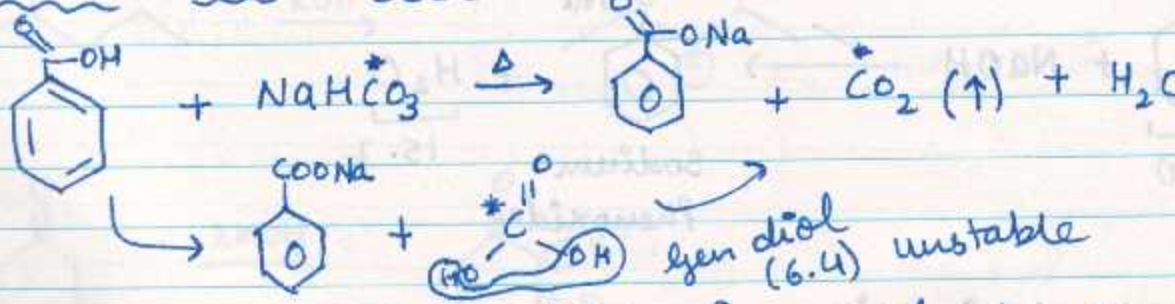
Q. Which of the following compounds will be soluble in aqueous NaOH? (9)



Picric acid, p-cresol, O-toluic acid

Q. When benzene sulphonic acid & p-nitrophenol are treated with $NaHCO_3$ the gases released are CO_2, CO_2

* Reactions with $NaHCO_3$:→



- It is a weak base which is used to separate phenol & benzoic acid.
- CO_2 is evolved during the reaction.

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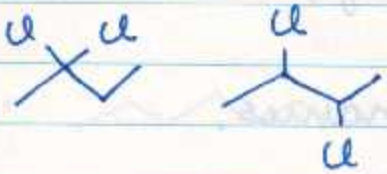
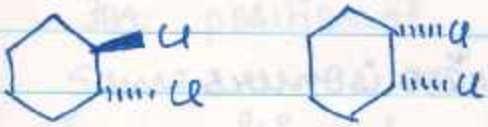
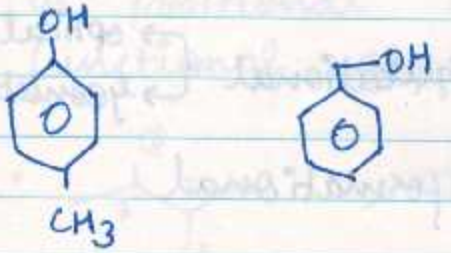
Isomerism

Isomeric forms	M.F.	Difference
	C_4H_{10}	Parent chain
	C_4H_8	Position of π-bond
	$C_4H_8Cl_2$	Position of Cl
	C_2H_6O	Functional grp.
	C_3H_6	Presence of π-bond, cyclic
	C_4H_9Cl	P. of Cl (config^n)
	$C_2H_2Cl_2$	cis, trans
	$C_6H_{10}Cl_2$	P. of Cl (orientation)
	C_7H_8O	F.G.
	C_6H_{12}	no. of C-atoms in P.C.

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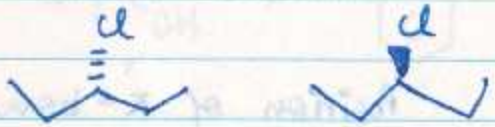
- Isomers are pair of diff. compounds having same molecular formula but diff. / at least one diff. property.



} Homomers (same but represented differently)

- Isomers must have diff. IUPAC names.

How to check isomers ?

→ i) Check the no. of atoms other than hydrogen
ii) (check DBE)
iii) They must have atleast one diff. property.

* Classification of Isomerism :→

- Isomers
  - Structural Or Constitutional Or Regio isomers
    - Chain
    - Position
    - Functional
    - Tautomers
    - Metamers
  - STEREO isomers
    - Configurational
      - optical
      - geometrical
    - conformational

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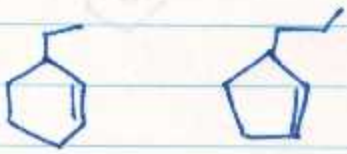
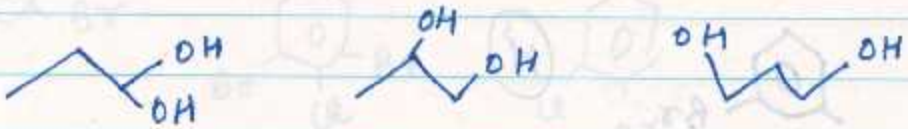
* Chain isomers :→ Pair of structural isomer having different parent chain length.



* Positional isomers :→

For positional isomers, P.C. length must be same.

In positional isomers, position of locant or functional grp or π-bond can change.



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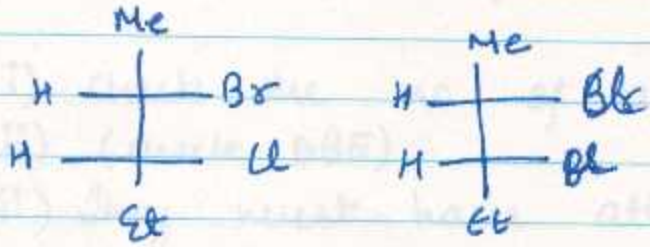
Q. Check whether chain / positional isomers

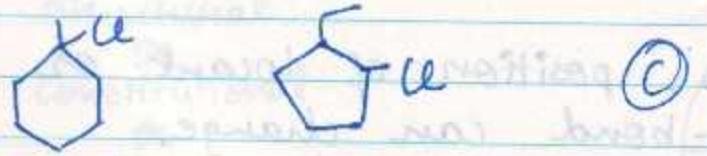
1) ©

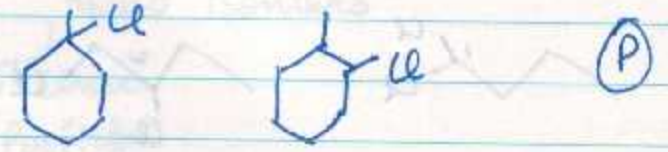
2) ©

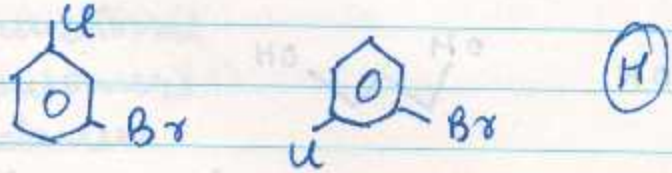
3)  (P)

4) ©

5) (P)

6)  ©

7)  (P)

8)  (H)

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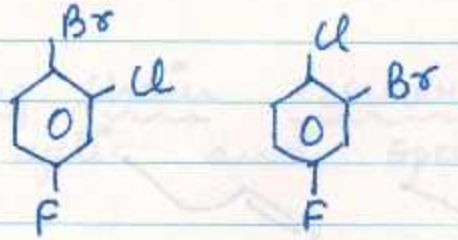
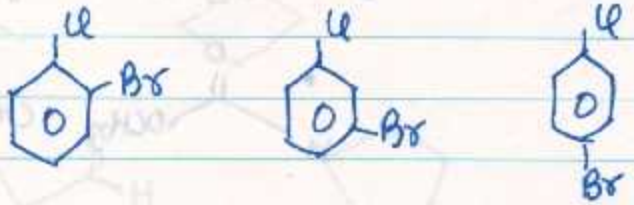
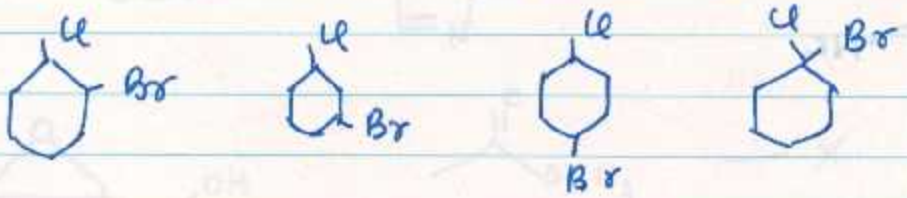
9)  (P)

10) $C_3H_5Br_3$ (P.I.)

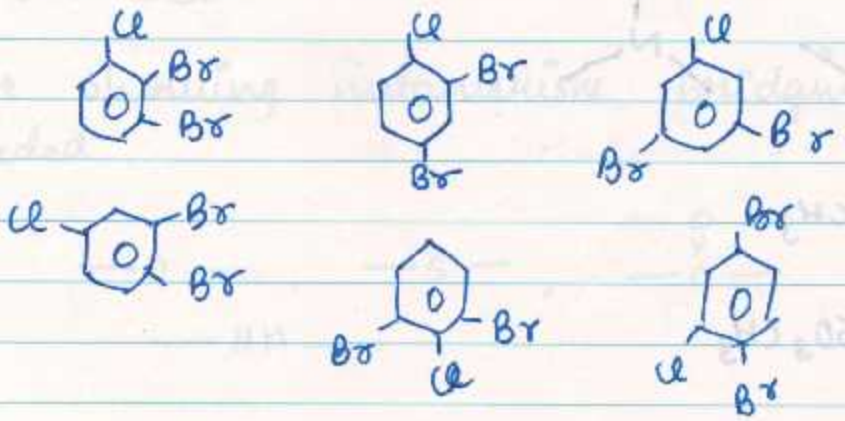
11) Chloro Bromo Benzene



12) Chloro Bromo Cyclohexane



13) Dibromo chloro benzene



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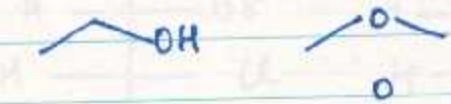
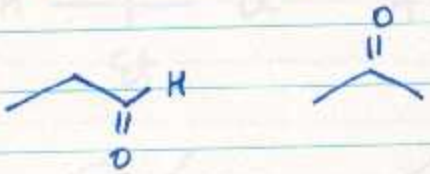
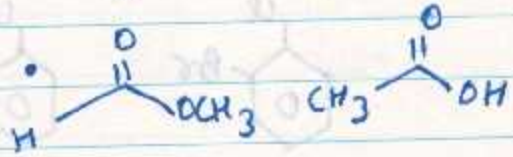
14) Chloro butene

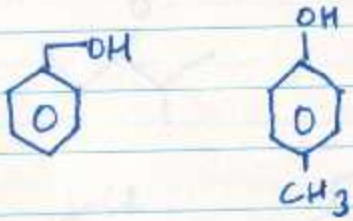
15) 2-Chloro -2- pentene

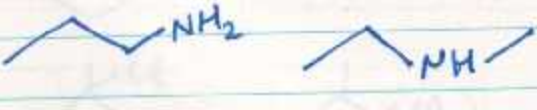
* Functional Isomers :→ Having diff. F. grps.

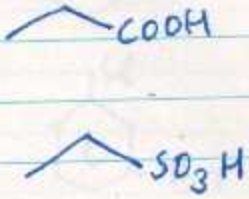












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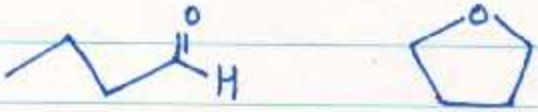
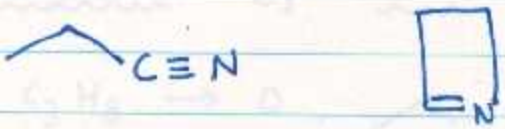
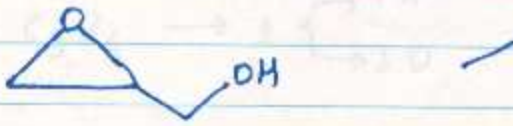
* Ring Chain Isomers :→ when P.C. in one cmpd is cyclic and open chain in other.

-
-
-
-
- 
- 
- 
- — X {epony is position not P.C.}

* Metamers :→

For showing metamerism, bridging f. grps are needed.

—O—, —S—, , —NH— } symmetrical B. f. grp.

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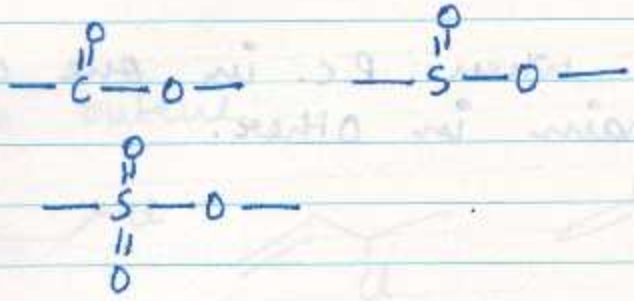
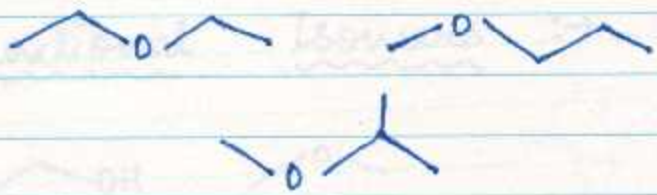
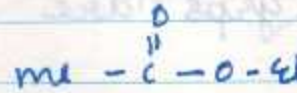
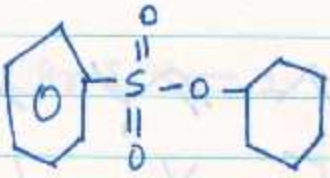
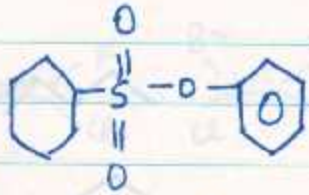


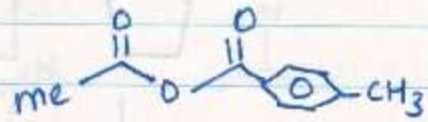
- Metamers are pair of structural isomers having different Alkyl groups across the bridging functional group.

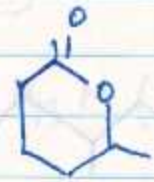
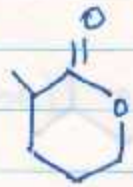
eg,





-  

- 

-  

** !! Preference Order :→ RTFMCP

Use this order in ~~[illegible]~~ case multiple types of isomers

- Calculation of Total Isomers :→

1) $C_3H_8 \rightarrow 0$, ①

2) $C_3H_6 \rightarrow 1$ → 1 π, → 1 O ②

3) $C_4H_{10} \rightarrow 0$, ②

4) $C_4H_8 \rightarrow 1$ → 1 π, → 1 O ⑤

5) $C_5H_{12} \rightarrow 0$, ③

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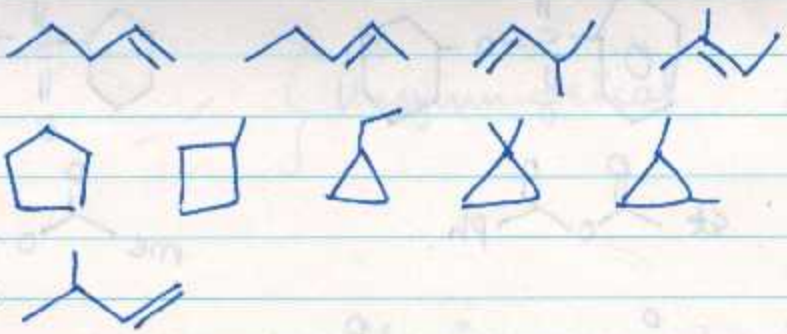
6) $C_5H_{10} \longrightarrow 1, \begin{cases} \rightarrow 1\pi \\ \rightarrow 10 \end{cases}$

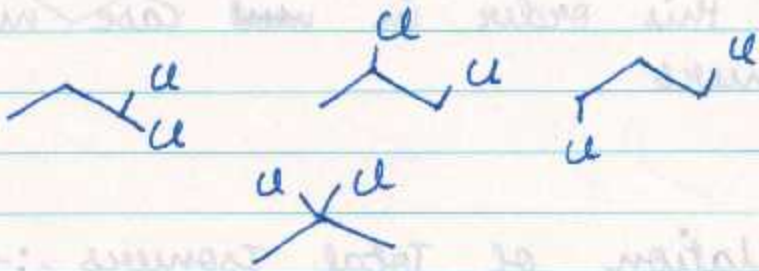


(10)

7) $C_6H_{14} \longrightarrow 0$

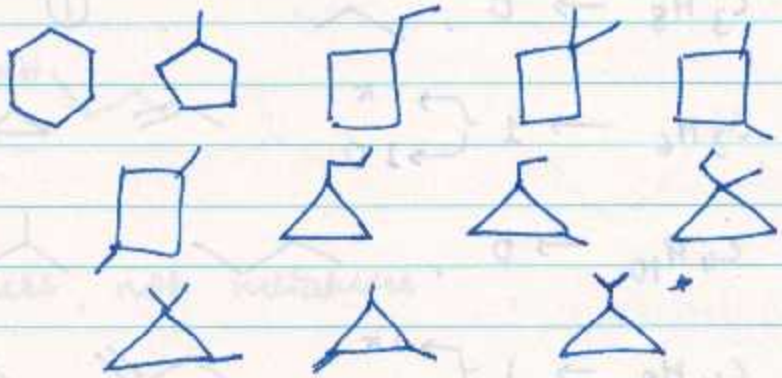
(5)

8) $C_3H_6Cl_2 \longrightarrow 0$



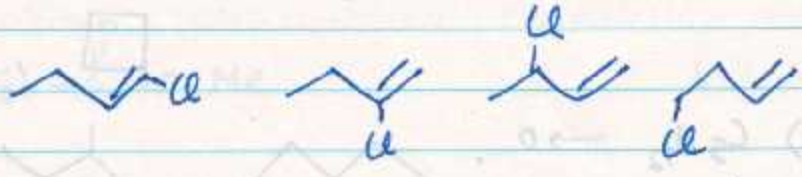
(4)

9) $C_6H_{12} \longrightarrow 1, \begin{cases} \rightarrow 1\pi \\ \rightarrow 10 \end{cases} \Rightarrow$

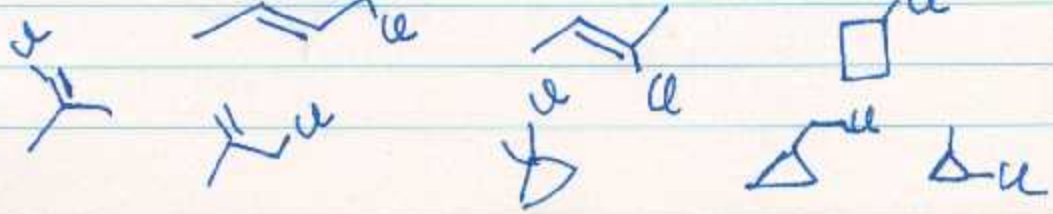


(12)

10) $C_4H_7Cl \longrightarrow 1 \begin{cases} \rightarrow 1\pi \\ \rightarrow 10 \end{cases}$



(12)



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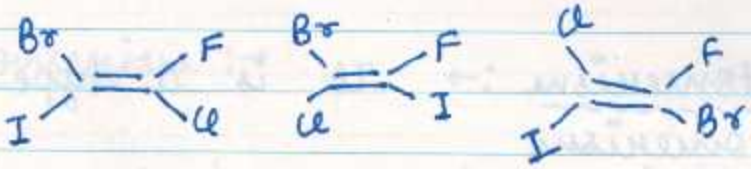
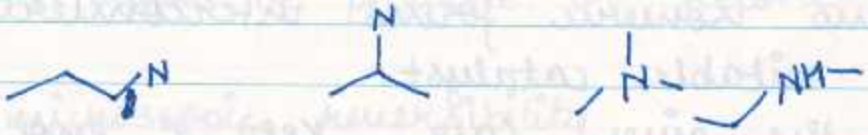
11) $C_2FClBrI$ — 1

(3)

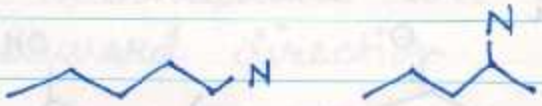


12) C_3H_9N — 0

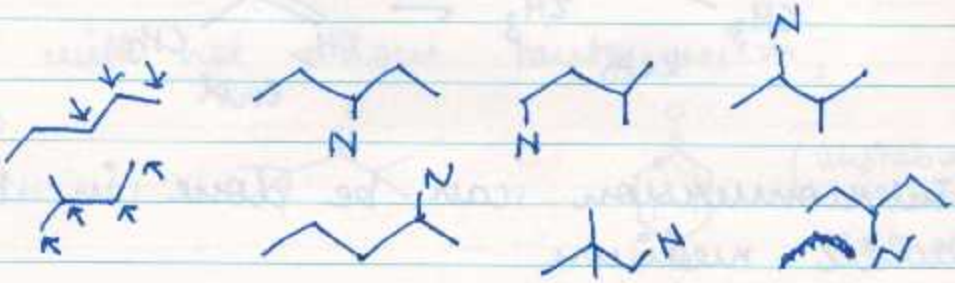
(4)



13) $C_5H_{13}N$ (1° Amine) → 0

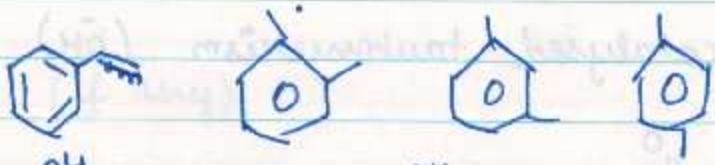


(8)



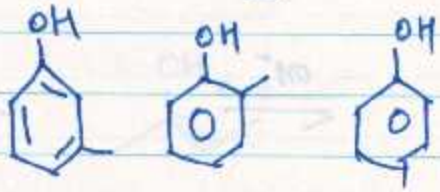
14) C_8H_{10} (Benzene ring) →

(4)



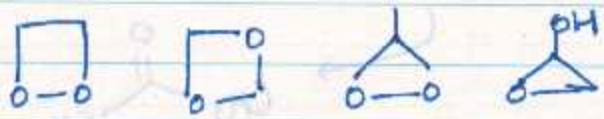
15) C_7H_8O (Phenols) →

(3)



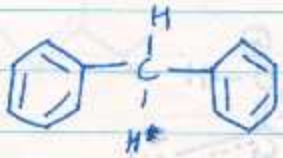
16) $C_2H_4O_2$ (cyclic) → 1

(4)



Q. How many different structures are formed when one of the hydrogen in diphenyl methane is replaced with deuterium.

→ $Ph-CH_2-Ph$



(4)

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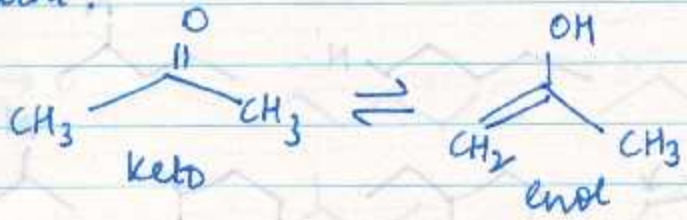
* Tautomerism :→ It is a type of functional isomerism.

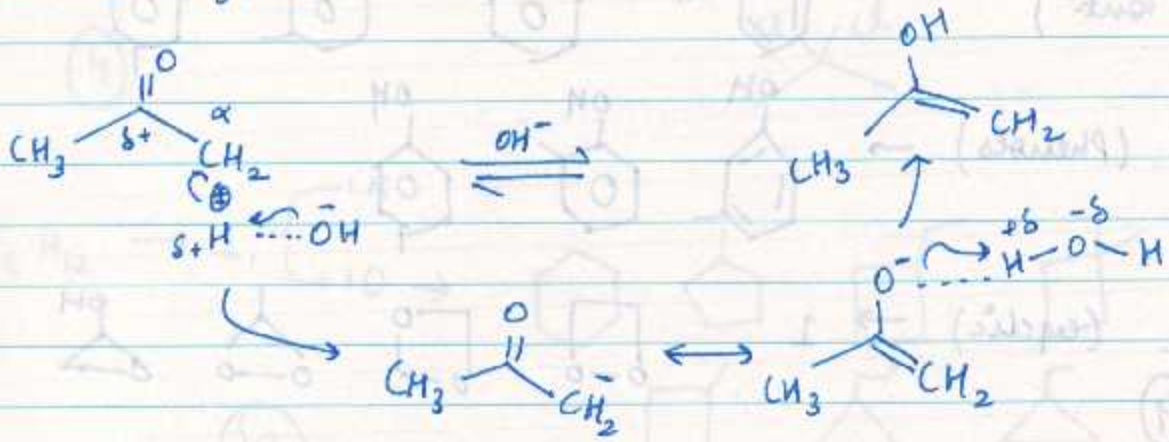
• Two isomeric forms interconvert in the presence of suitable catalyst.

In the given case, keto & enol forms are in equilibrium.

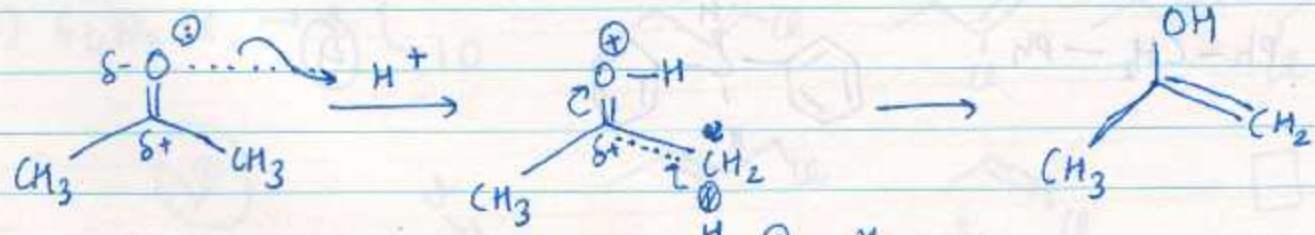


- Interconversion can be done in basic as well as acidic medium

• Base catalysed tautomerism ($\bar{O}H$)



• Acid catalyed tautomerism (H^+)



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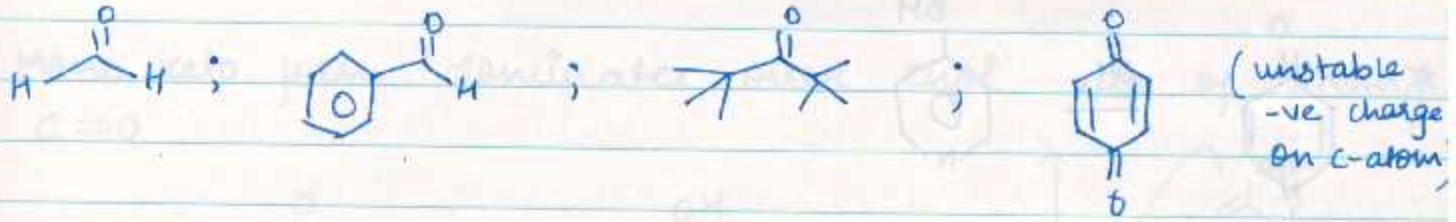
· Condition for Tautomerism :→

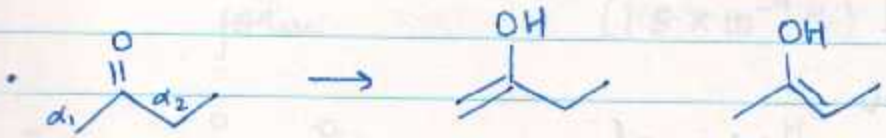
i) At least one α-H must be present in ketone

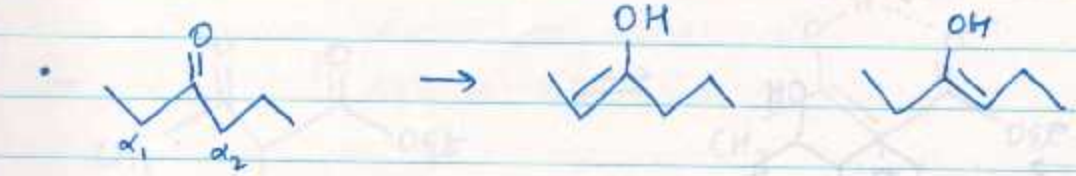
* PMR : Principle of microscopic reversibility.
In a reversible rxn, intermediates are same in forward as well as backward direction.

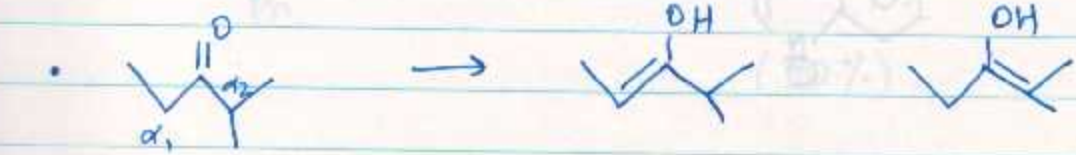
Compound which will not show tautomerism,



Q. Draw enol form(s) (if any)







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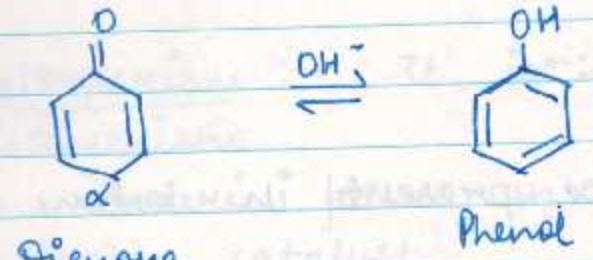
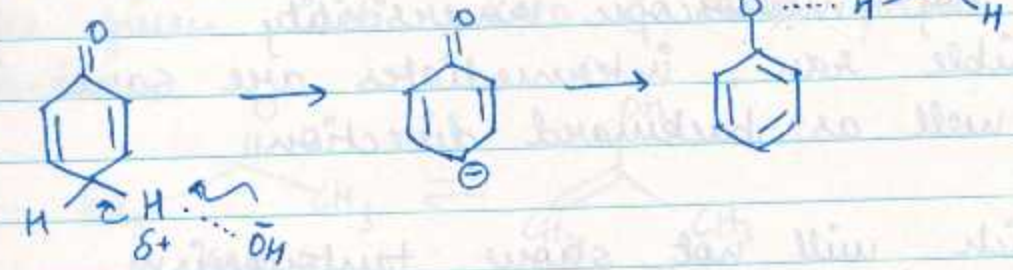
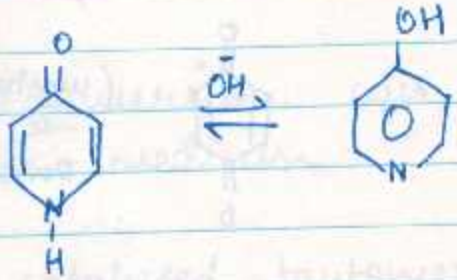
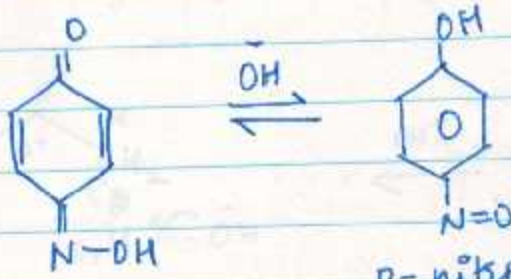


Dienone

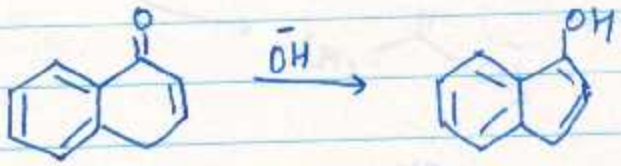
Phenol

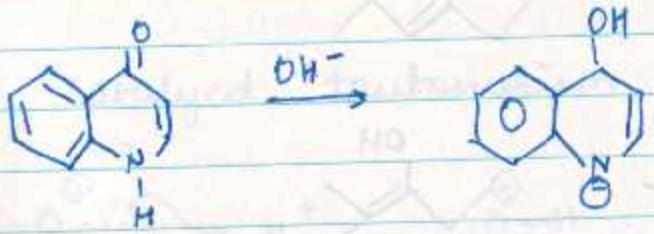






p-nitroso phenol





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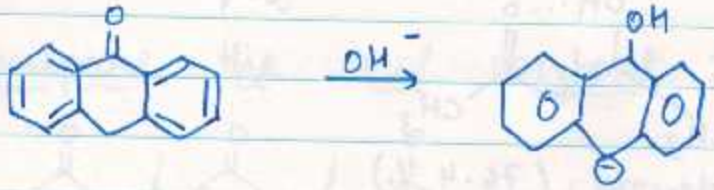
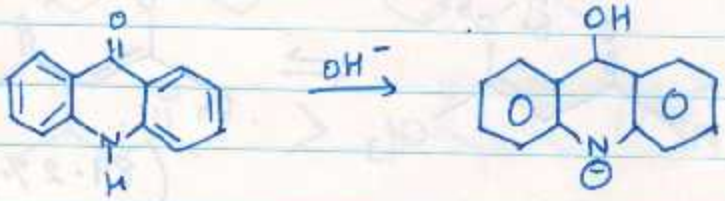
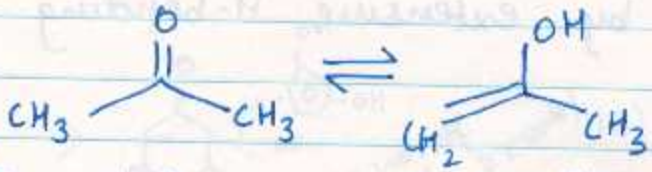
* 

* 

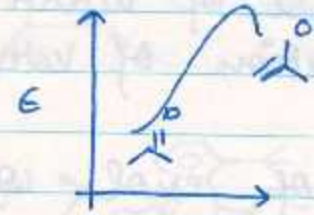
* Comparison of keto & enol :→

- Mono keto form dominates over enol coz of strong C=O



mono keto form

enol (1.5×10^{-4} %)



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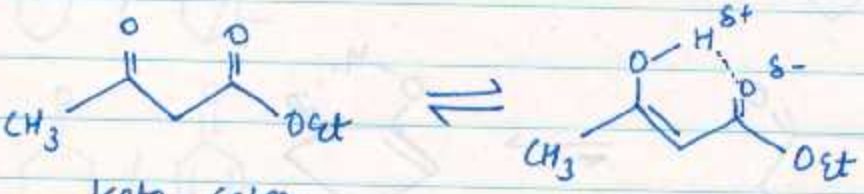
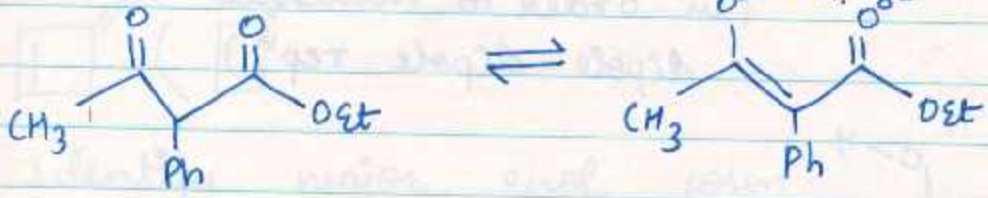


keto - Ester

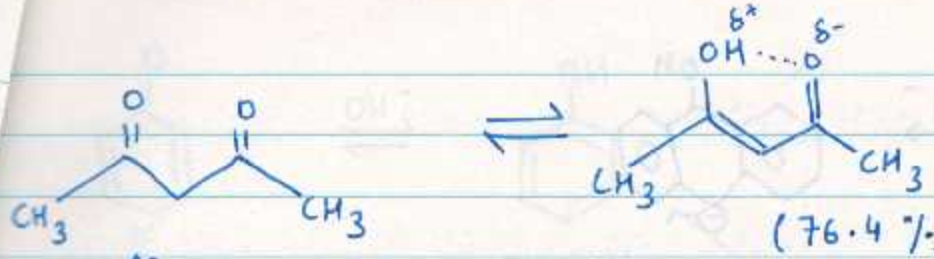
(8 %)

-



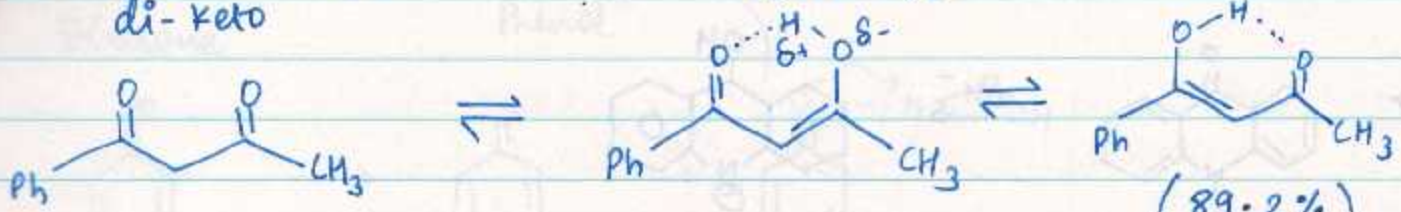
(30 %)

* All data are taken in liquid phase



(76.4 %)

di-keto



(89.2 %)

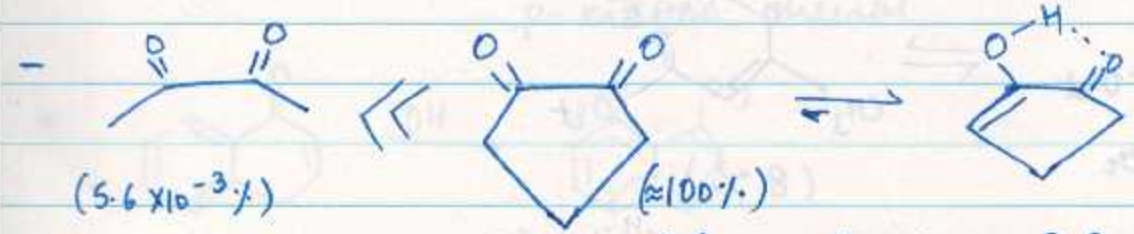
* Presence of phenyl ring will ↑ conj. in enol form.

- Effect of solvent on enol content :→

In case of water, enol content will be less, coz of stabalisation of keto form by extensive H-bonding.

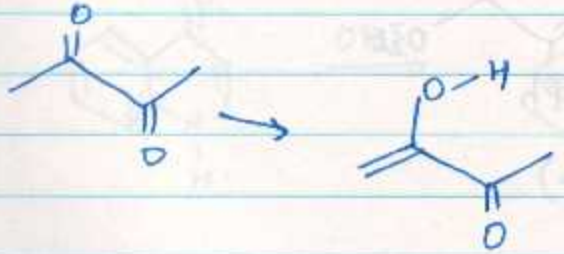
- Order of enol content,

di-keto (cont. active methylene) > keto-ester > mono-keto



(5.6 x 10⁻³ %) (≈100 %)

(in order to minimise dipole-dipole repⁿ)



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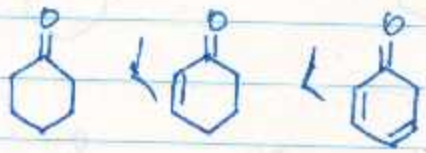
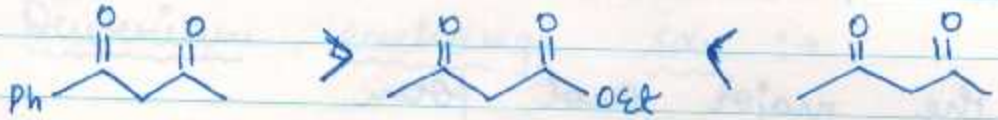
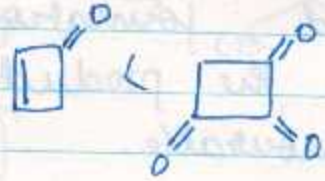
Q. Compare the enol content :→

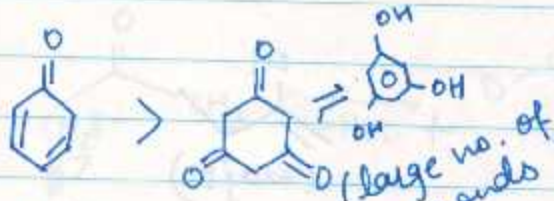
1)  (Aromaticity)

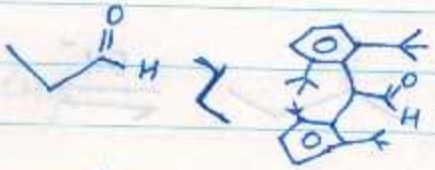
* 2) (Rep^n due to change in hyb.)

3)  a > b

4)

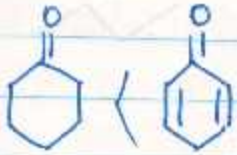
9) 

* 5)  (large no. of ↖ bonds break)

10)  (Fusion type enol)

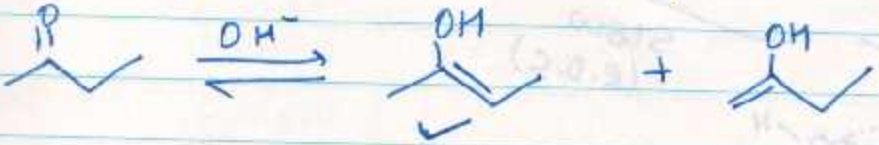
6)

* 11) (rotation across bond → development of strain)

7) 

8)

Q. Identify major enol form



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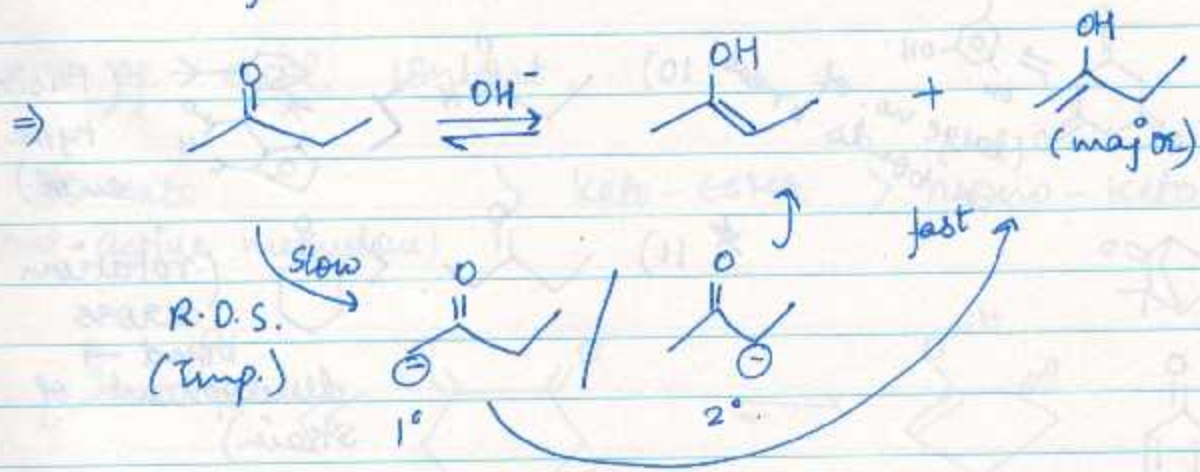
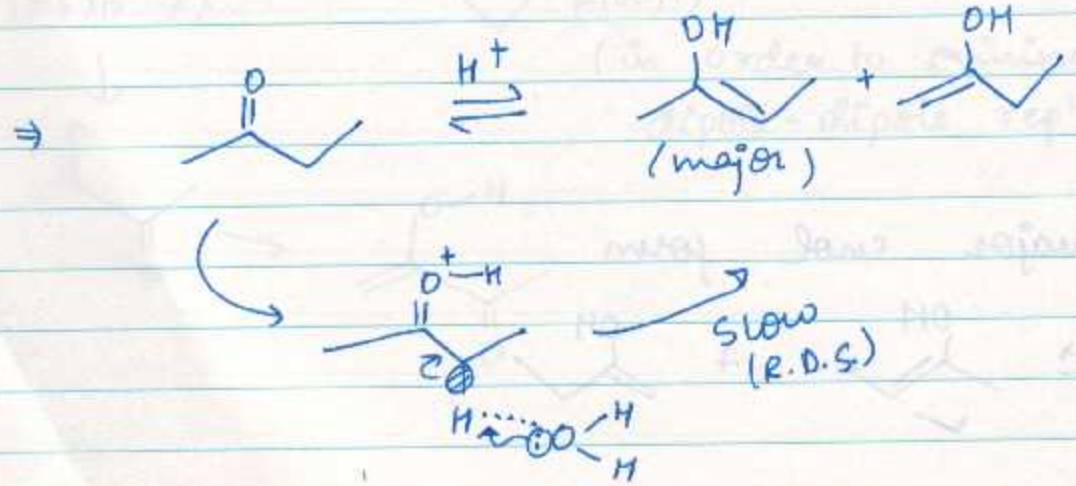
* % enol is favoured by these factors,

i) Acidic H in keto form
ii) Aromaticity in enol
iii) Intramolecular H-bonding in enol
iv) Conjugation in enol
v) lesser repulsions / strain in enol

→ Identifying the major enol form

• In basic med., formation of carbanion is R.D.S. So forming the product with the stable carbanion is more favourable.





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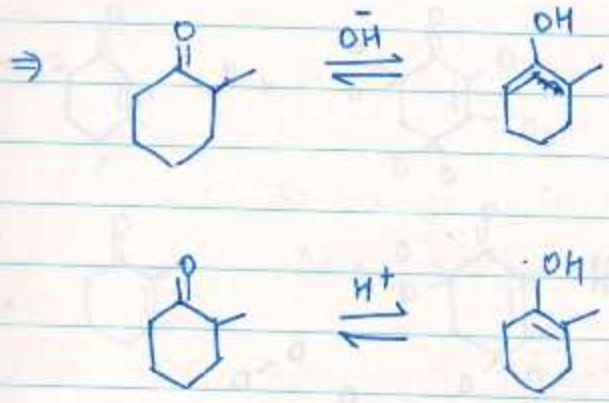
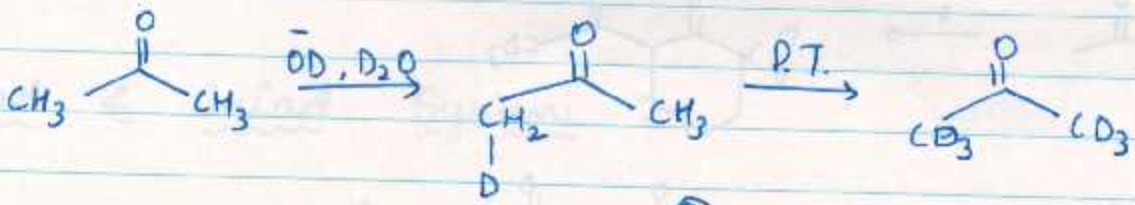


* Deuterium exchange rxn :→



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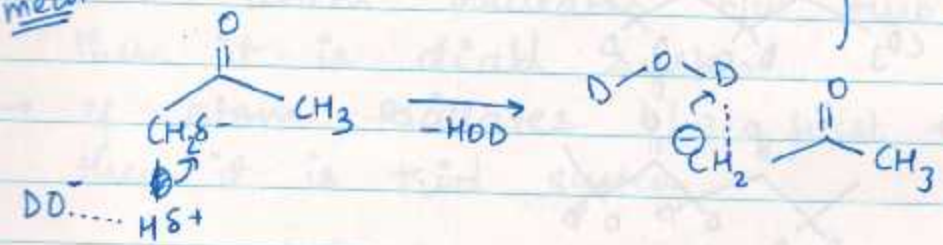

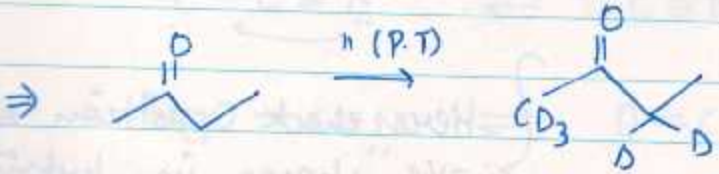

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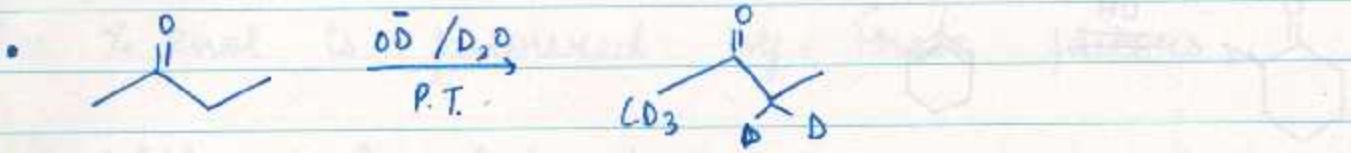
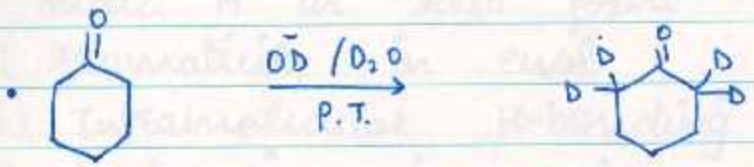
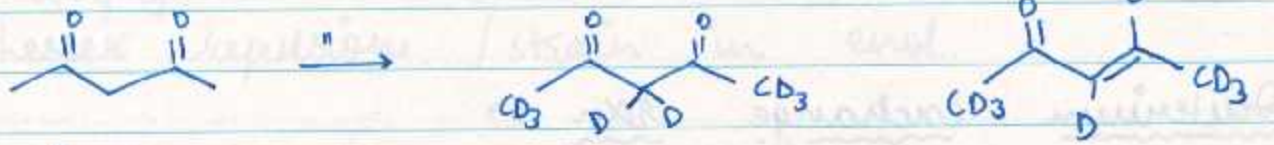
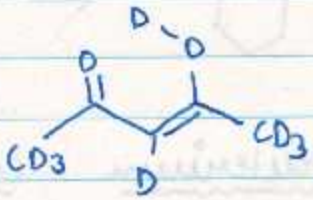
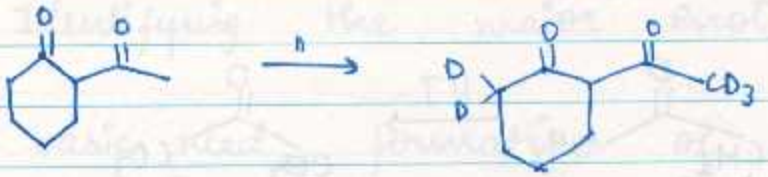
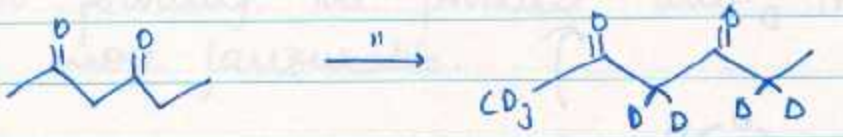


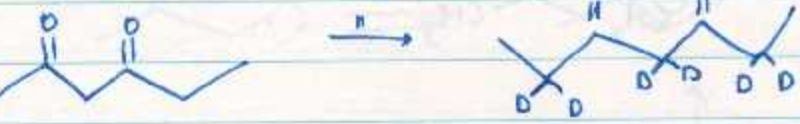


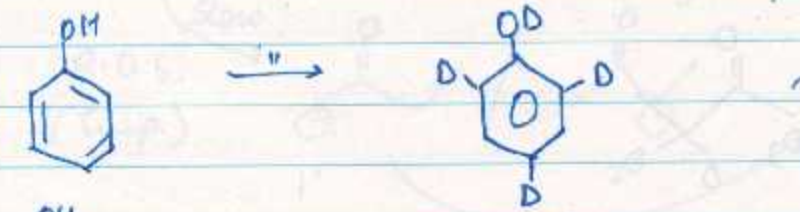


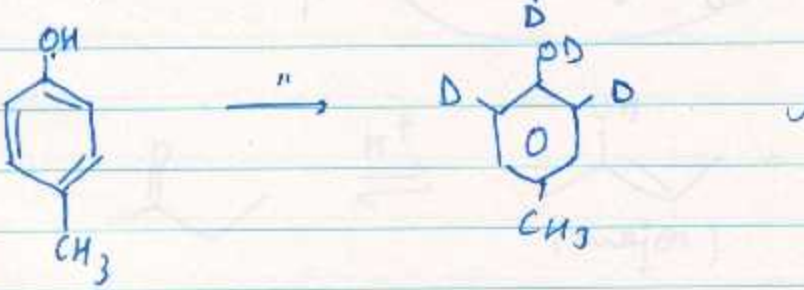




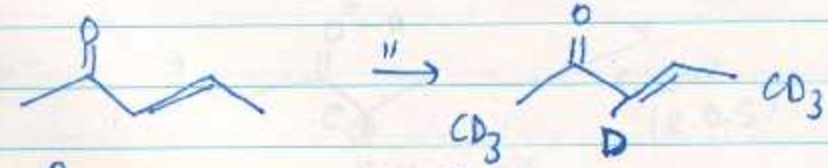








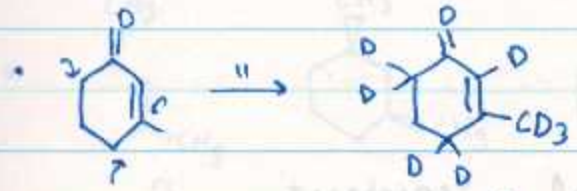
Here check position of -ve charge in hybrid & if there is 'H' present replace extra 'H' by D.

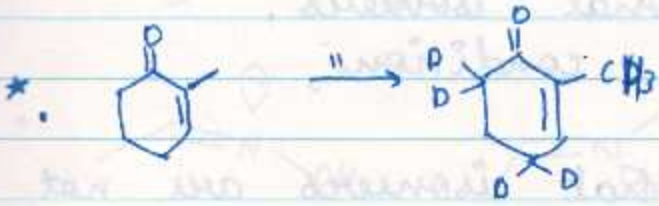


Remove most acidic 'H'

Draw resonance hybrid

Replace 'H' with 'D' at positions having δ-





* Diad & Triad System :→

→ When atom oscillates b/w two adjacent atoms then it is diad system.

→ If atom oscillates b/w first & third atom then it is triad system.

- $H-C\equiv N \rightleftharpoons \overset{\ominus}{C}\equiv\overset{\oplus}{N}-H$) Diad

- $H-O-C\equiv N \rightleftharpoons O=C=N-H$) Triad

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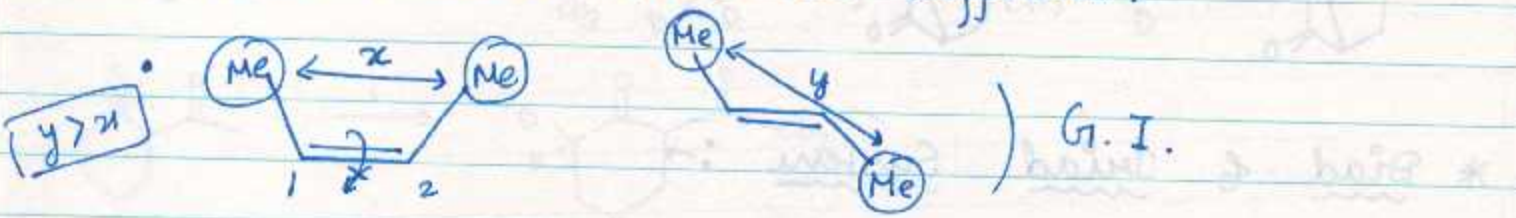
* Geometrical Isomerism :→

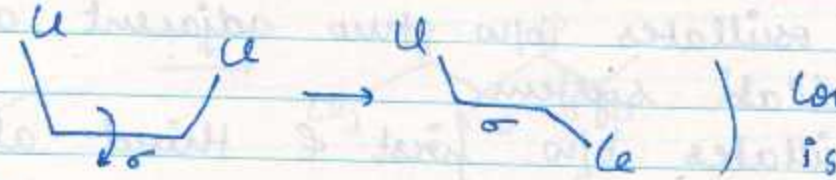
- They are pair of configurational isomers.
- They follow following two conditions,

i) Restricted rotation so that isomers are not interconvertable

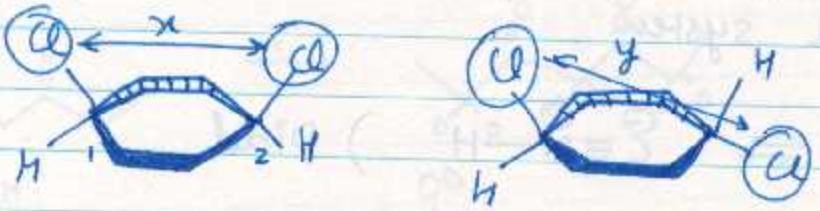
ii) Areal distance must be different.



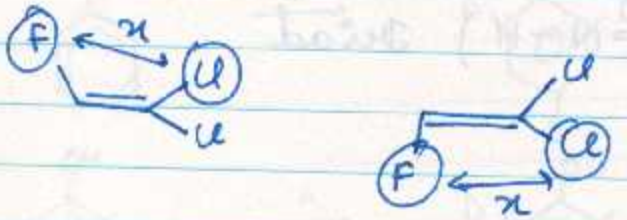
) G.I.



) Conformational isomers (not G.I.)



) G.I.



) Not G.I.

) Not G.I.

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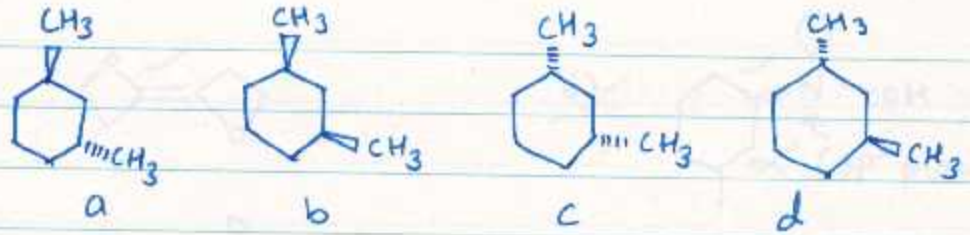
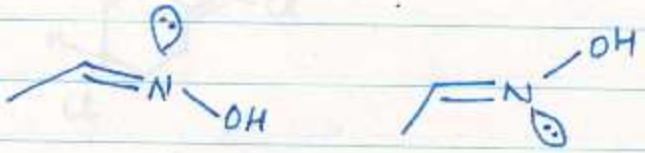
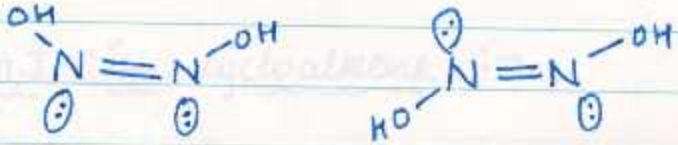


a b c d

{ab ; ac ; bd ; are G.I



) G.I.



) G.I.

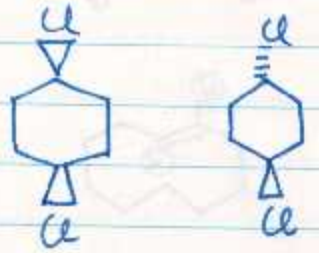
G.I. can be shown even without carbon.

* $R_1-C\equiv C-R_2$ Can alkyne show G.I. ?

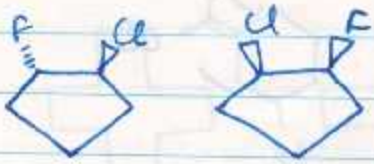
⇒ No. {Axial dist. constant}

Q. How many min. carbons are needed for an alkene to show G.I.

→ Ans. 4. {Don't use substituents}



) G.I.



) G.I.

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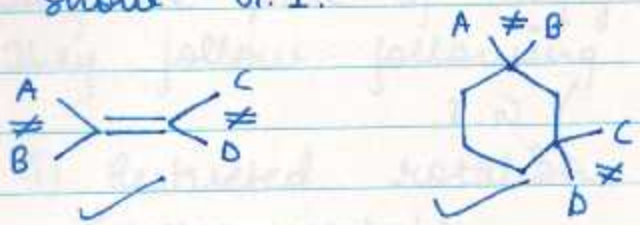
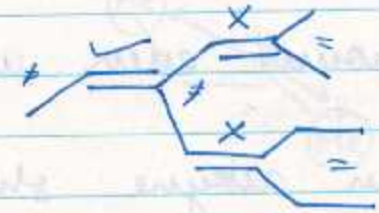
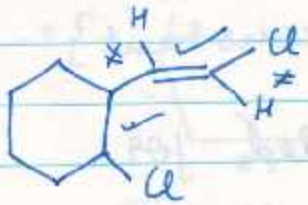
* ABCD rule :

To show G.I.



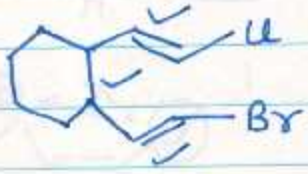
eg.





Q. Identify G.I.

1)



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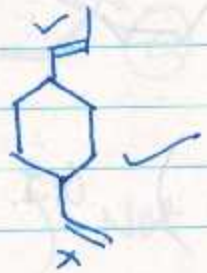
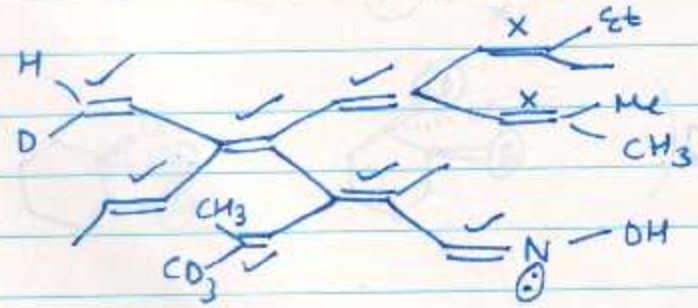


3)



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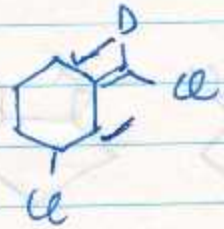

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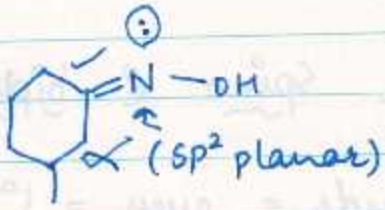
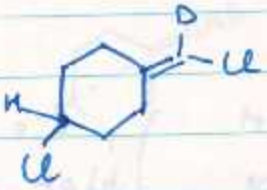
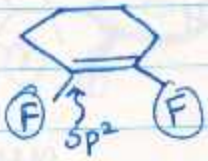
5)

6) 

7) 

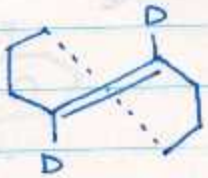
* G.I. in cycloalkene :→

→ 

(unstable)

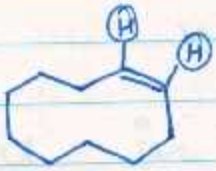
GI is not possible in cycloalkenes except in cases of bigger rings where both isomeric forms exist.

→



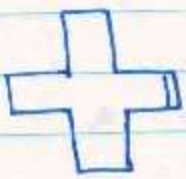
) ≠ G.I.

→



) ≠ G.I.
(Areal distance)

→


) ≠ G.I.

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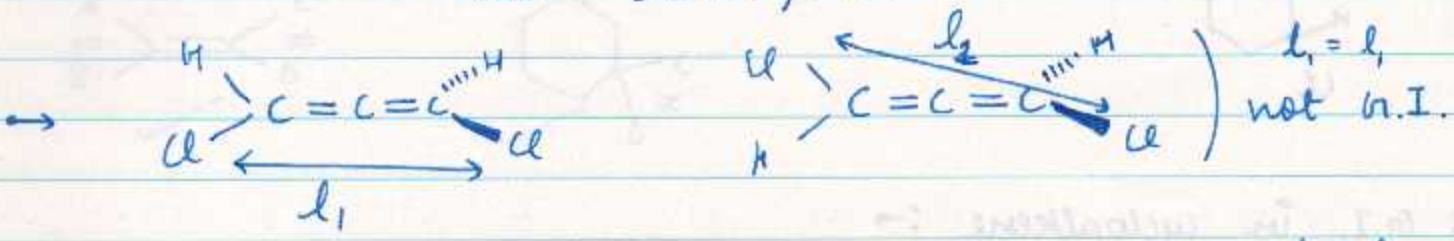
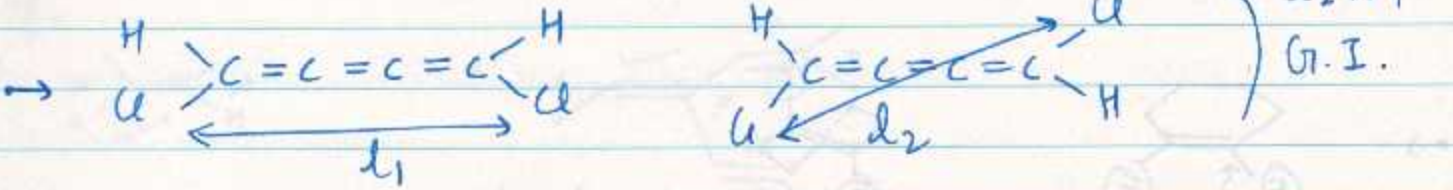
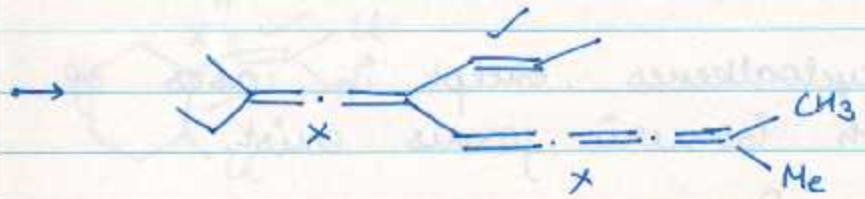
* Cumulenes, Spiro & biphenyls :-

no. of π bonds = even = 1ar
" = odd = same plane







SPIRO

{Replace uniform ring as π bond}

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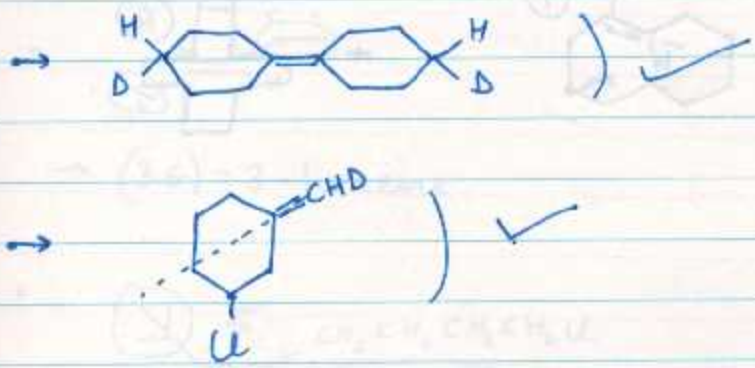
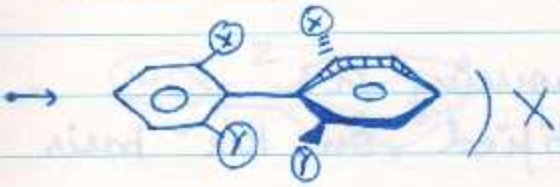
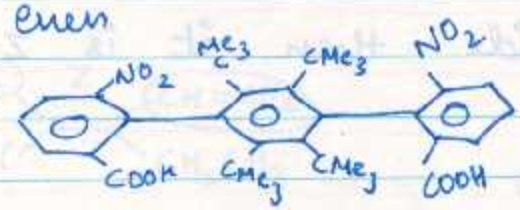
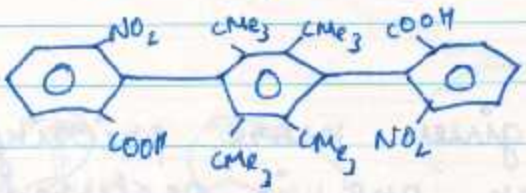


POLYPHENYLS



even

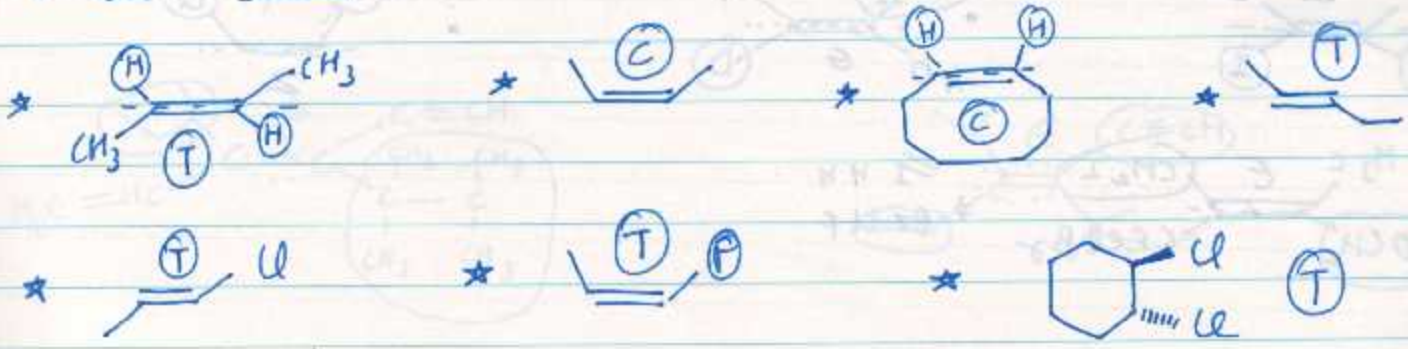




(odd)
(ATROP Isomers)
↳ Restricted rotation due to steric crowding

* Configurations in G.I. :→

1] Cis - Trans



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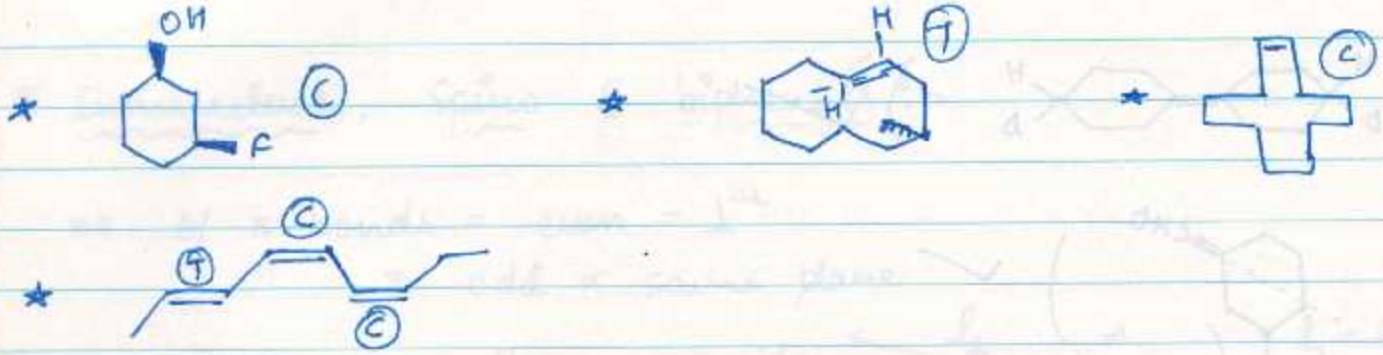


→ Zussamen (same)

* E - Z Configuration :→

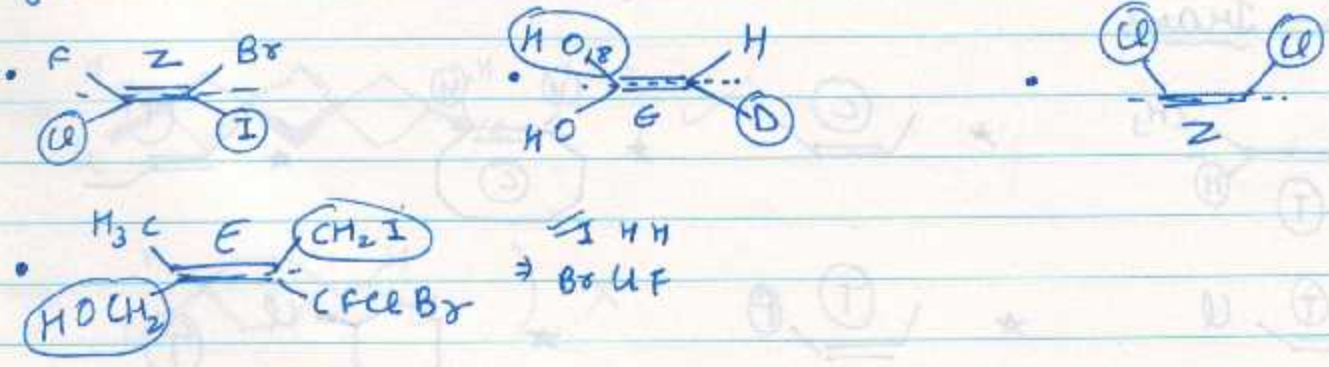
↳ Entgegen (opp.)

→ It is defined for the systems showing G.I.
→ Higher priority groups are identified on the basis of C.I.P rules.
→ If H.P.G are on same side then it is Z-conf. or else E-conf.

CIP Rules :

i] Higher Atomic No. will be given more priority
ii] In case of isotopes, heavier one is preferred.
iii] If directly connected atoms are identical then compare the next three directly attached atoms.

Eg,



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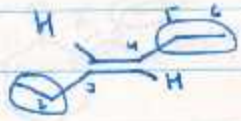
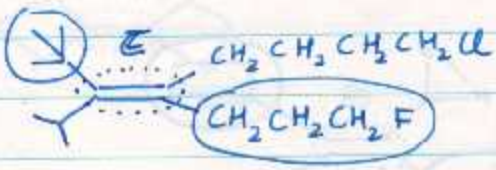


→ (3E)-3-hexene.

•



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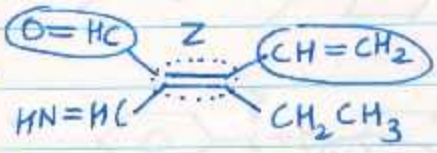
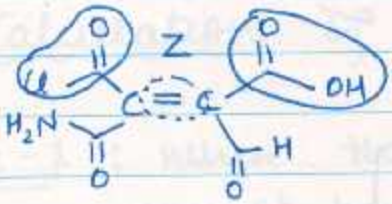


→ If π-bond is present in the substituent then break π-bond & satisfy valency by ghost atom

•



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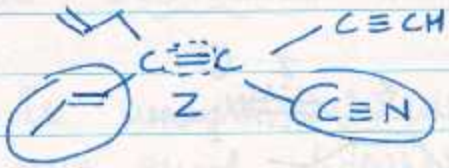
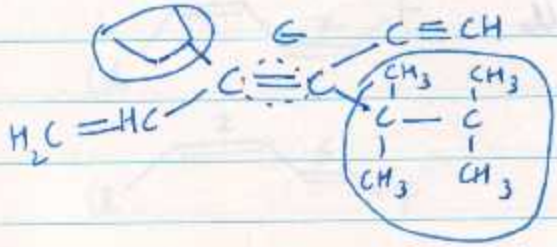
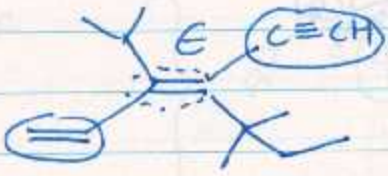
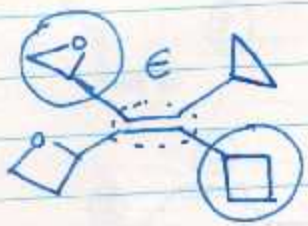
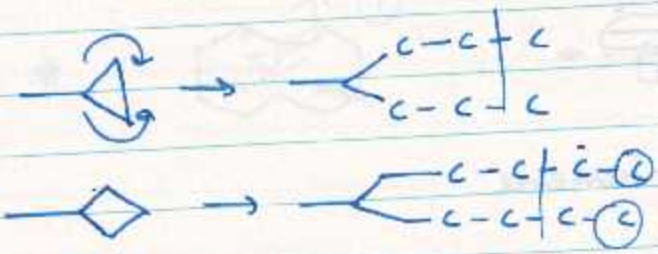


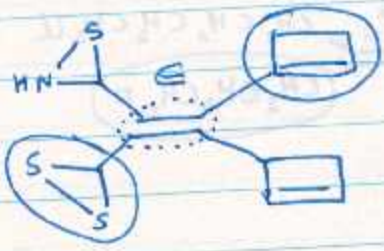
• When real & hypo. are almost identical then real is preferred.

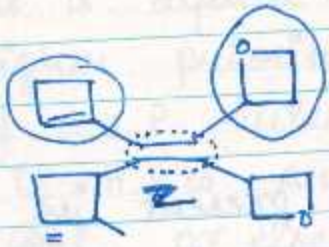


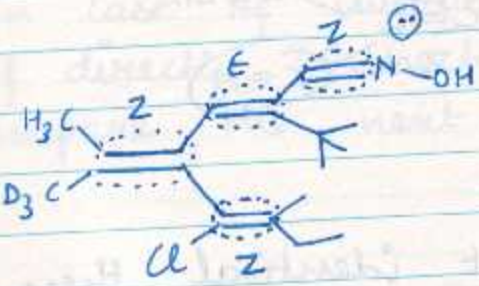


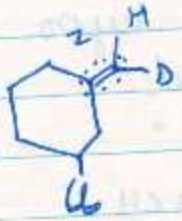


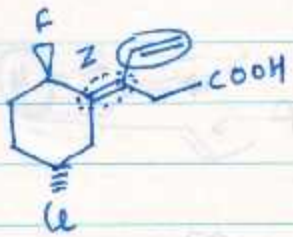
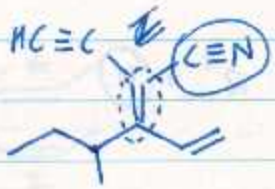
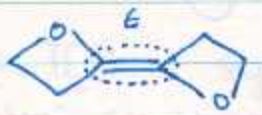




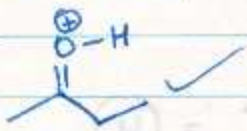
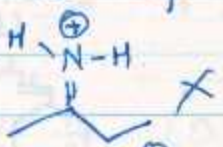
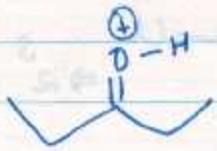
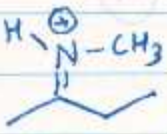
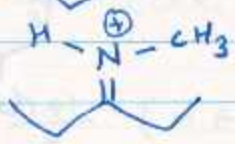


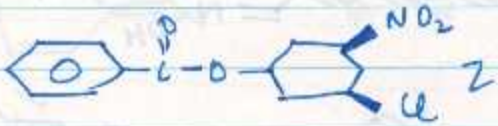
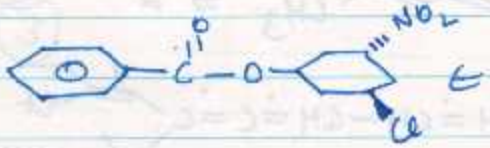




• Will they show GI after acidification? (anhydrous med.)

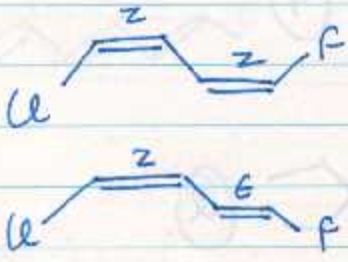
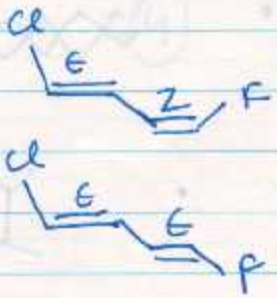






* Calculation of geometrical Isomers :→

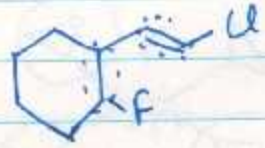
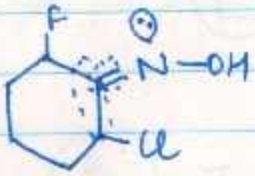
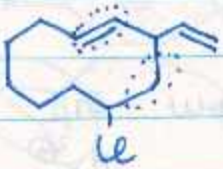
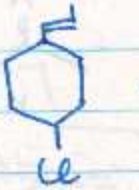
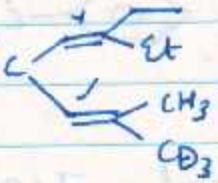
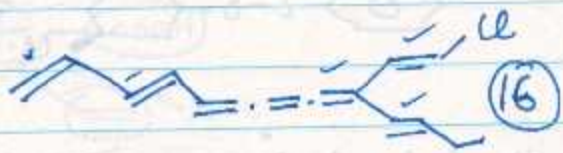
Case-1 : When the structure is unsymmetrical (which cannot be cut into two equal halves) {except across molecular plane}

T.G.I. $= 2^n$ where, n = no. of systems show GI.

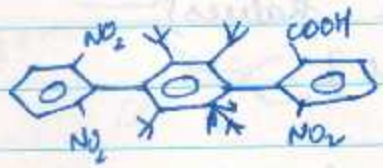



$2^2 = 4$

Ex 2: 1, 2, 3, 4, 6, 7, 9, 11, 40, 41, 42, 43, 44, 48, 49, 50, 65.

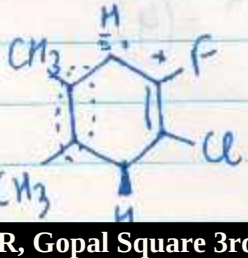
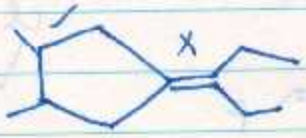
-  ⇒ $2^2 = (4)$
- ⇒ $2^2 = (4)$
-  ⇒ $2^2 = (4)$
- ⇒ (2) Decalin
- ⇒ (2)
-  ⇒ $2^2 = (4)$
- ⇒ $2^3 = (8)$
-  ⇒ $2^2 = (4)$
- ⇒ 2^2 (4)
- ⇒ $2^4 = (16)$
- $CH_3-CH=CH-CH=C=C$  (4)
-  (16)

- In case of resonating structures draw / use structure having max. stability

Ans.  ✗

- (2)

Ans. ✗

- (4)
-  (2)
-  (2)

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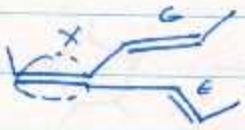
-  (4) { CIP Rule Z > ∈ }

Case II: symmetrical open chain molecules having 'n' systems showing G.I.

$$T.G.I = 2^{n-1} + 2^{p-1}$$

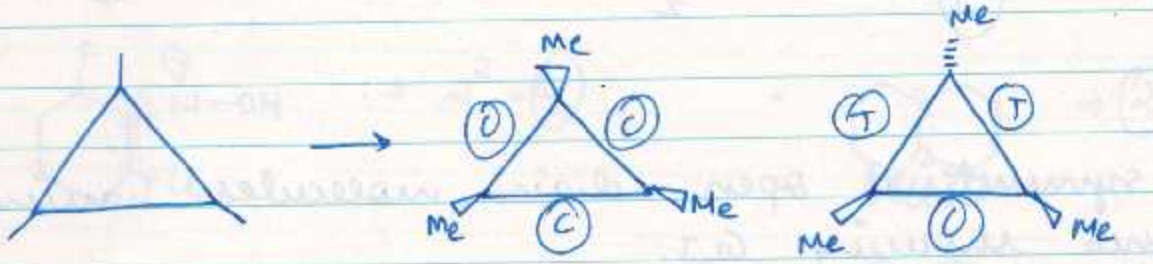
where,

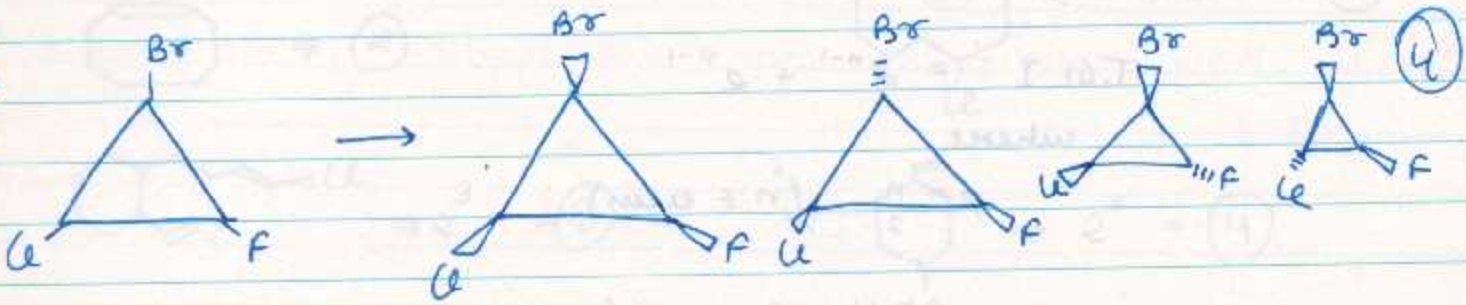
$p = \frac{n}{2}$ ($n \in$ even)

$p = \frac{n+1}{2}$ ($n \in$ odd)

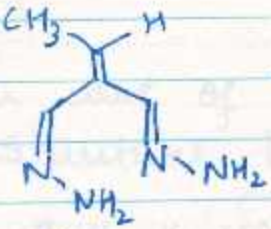
- $\Rightarrow 2^{2-1} + 2^{1-1} =$ (3)
- $\Rightarrow 2^2 + 2^1 =$ (6)
- $\Rightarrow 2^3 + 2^1 =$ (10)
- $CH_3-(CH=CH)_5-CH_3$ $\Rightarrow 2^4 + 2^2 =$ (20)
- $\Rightarrow 2^5 =$ (32)
- $\Rightarrow 2^2 =$ (4)

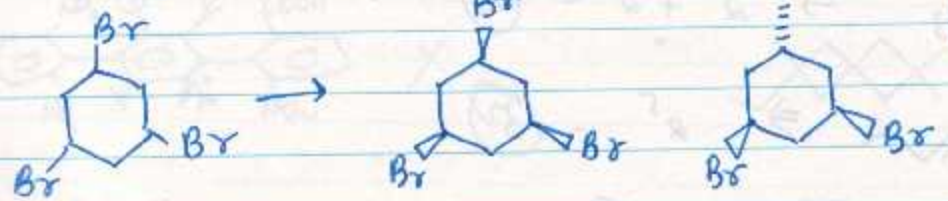
Case III : Draw & check

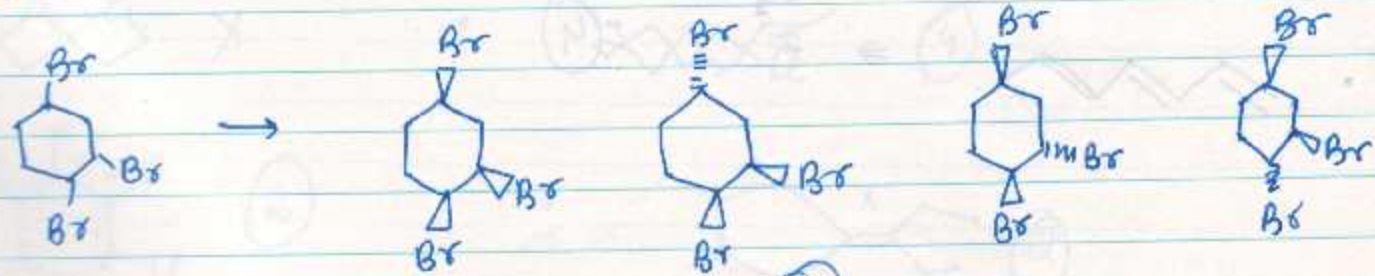
-  (2)

-  (4)

- (4)

-  → EE, EZ, ZZ, ZE (4)

-  (7)

-  (4)

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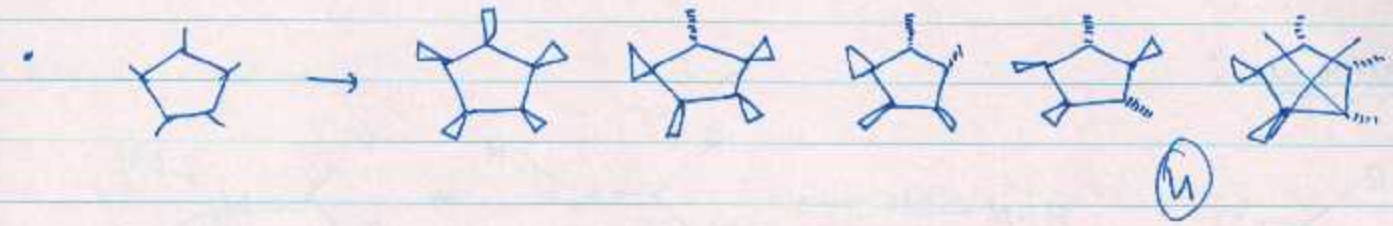
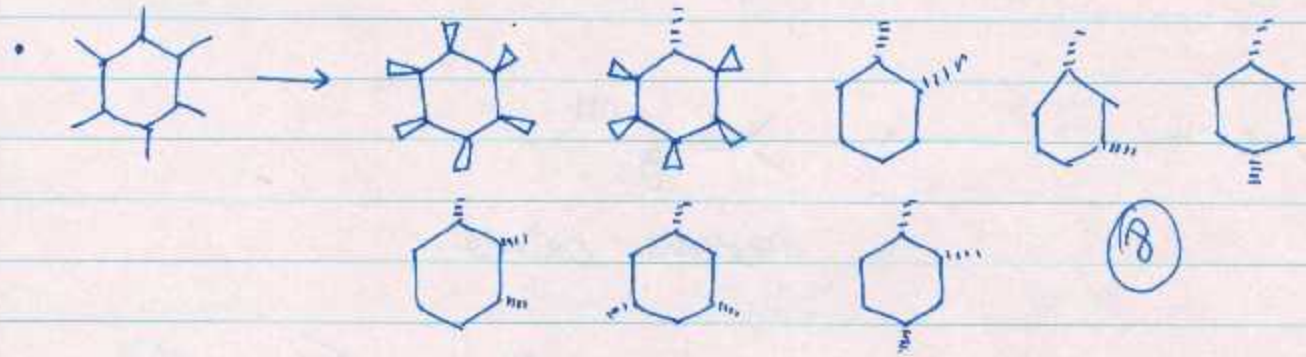
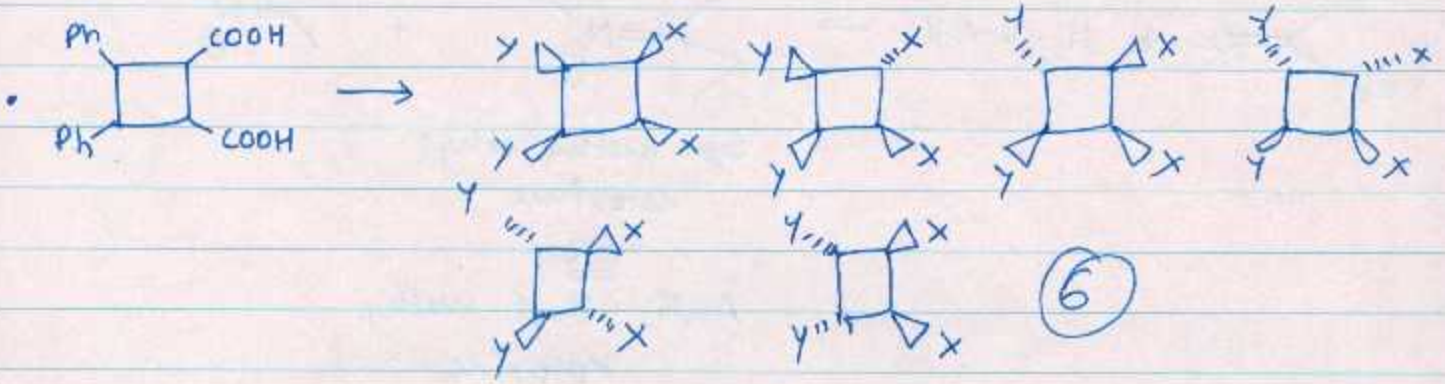


(4)



(8)

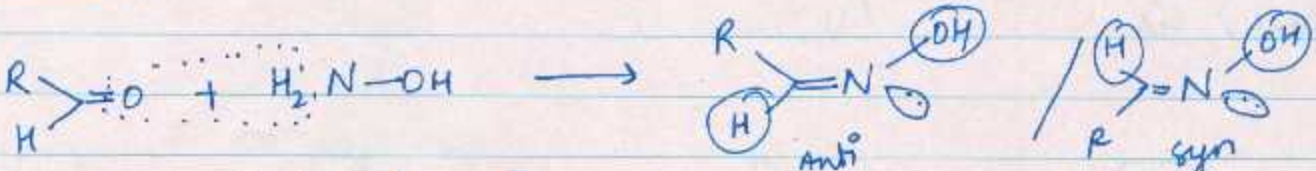


(6)

* Syn & Anti° :→

Syn → same
Anti → opp.

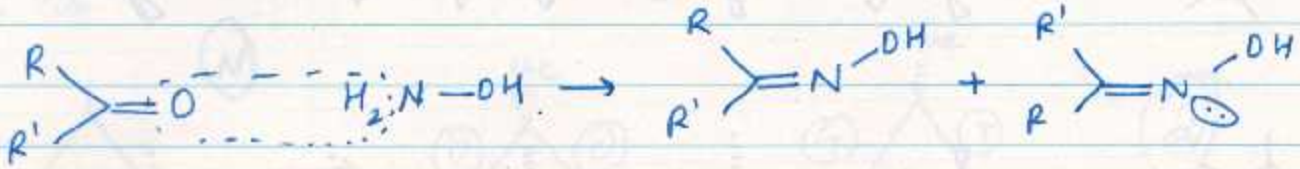
• Aldoxime :



Hydroxyl amine

Here syn / anti is decided w.r.t. position of 'H' & 'OH'.

• Ketoxime :



#

Acetone oxime

#

Syn methy ethyl ketoxime

OR

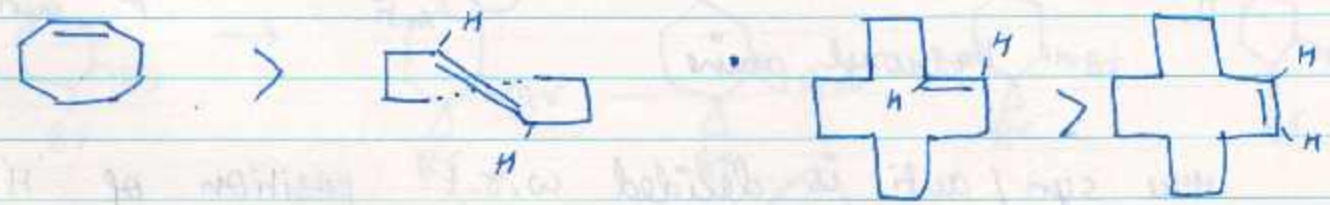
Anti ethyl methy ketoxine

* Impact of Cis - Trans on physical properties :→

Stability Ring size (cycloalkene)

Cis > Trans [8, 11]

Trans) Cis (11, ...



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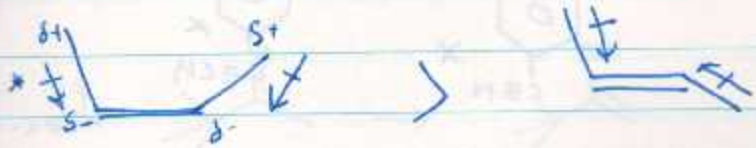
- Dipole moment,

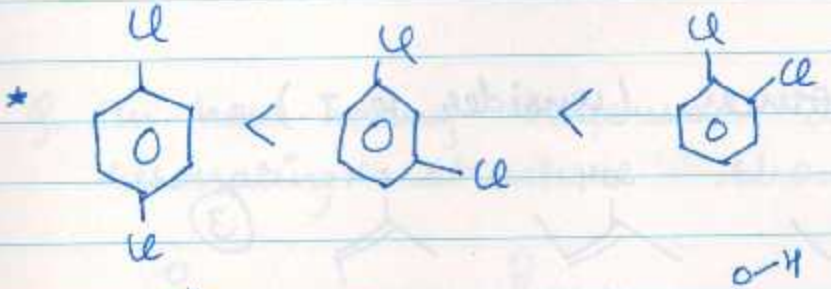
  - boiling pt. $\propto \mu$
  - melting pt. $\propto$ crystal lattice energy

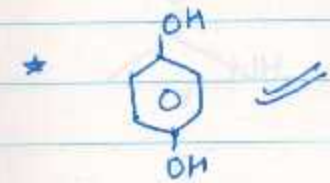


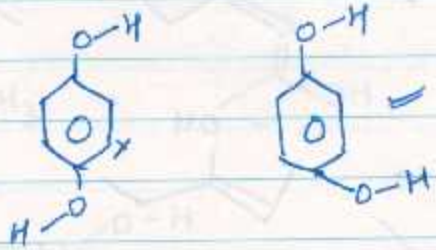
B. P., C > T

M. P., T > C

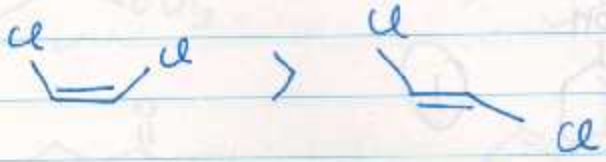
Cis-2-butene Trans-2-butene

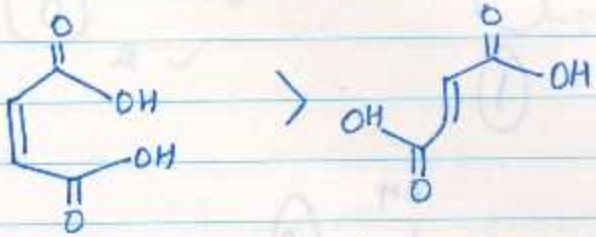






Rest.





Maleic acid Fumaric acid

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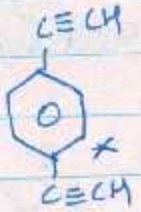
Which of the following have non zero dipole ? (4)

$CH_3-C\equiv C-CH_3$ (×) , $H-C\equiv C-CH=CH_2$ (✓)

$CH_2=C=CH_2$ (×) , $CH_3-C\equiv N$ (✓) ,

(×) ,



(×)

resonance

CO_2 (×) , SO_3 (×) ,

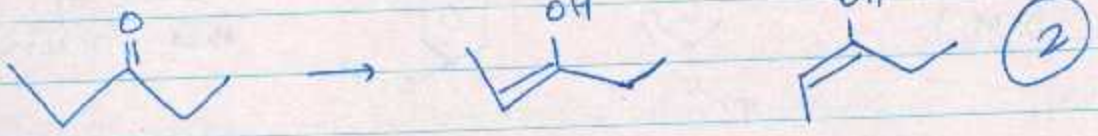
(✓) ,

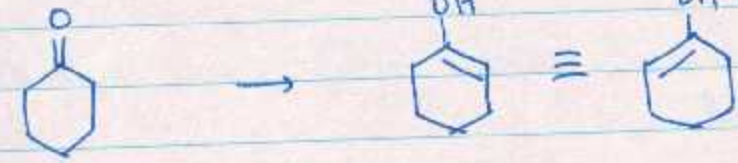
(×) , C_2H_2 (×) , C_3H_4 (✓) (Alkyne)

$H-C\equiv C-CH_3$

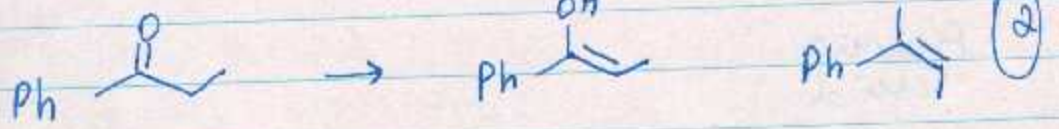
Q. Calculate total enol forms (consider G.I.)

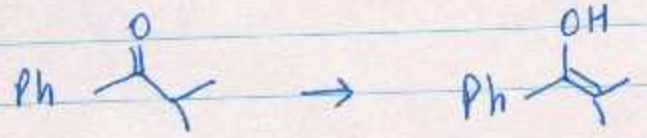
1) (3)

2)  (2)

3)  (1)

4) (1)

5)  (2)

6)  (1)

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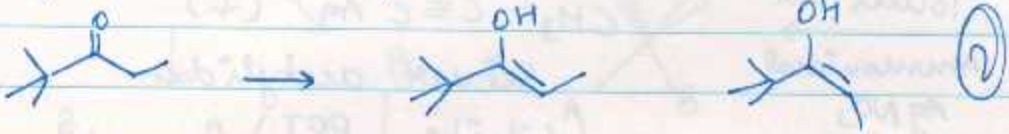
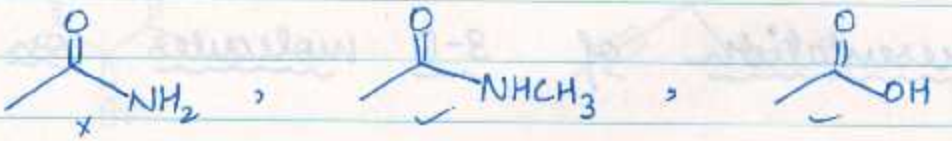
7) (3)

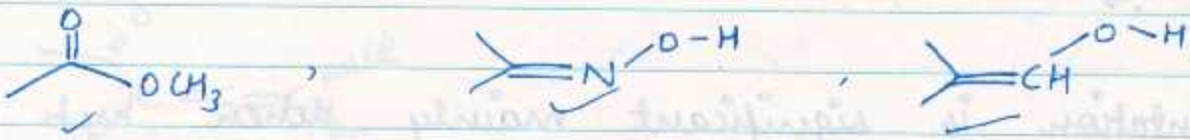
8) (1)

9) (1)

10)  (2)

Q. In how many compounds atleast one valid resonating structure shows G.I.





• How to differentiate terminal & non-terminal alkyne ?

- Fundamental diff. b/w them is presence of acidic 'H' in terminal alkyne.

$*CH_3-\overset{sp}{C}\equiv\overset{\delta-}{C}-\overset{\delta+}{H} \xrightarrow[\text{Ammoniacal } AgNO_3]{\text{Toller's Test}} CH_3-C\equiv C^-Ag^+ (\downarrow)$

silver acetylide (white PPT)

$CH_3-C\equiv C-H \xrightarrow[Cu_2Cl_2]{Amm.} CH_3-C\equiv C^-Cu^+ (\downarrow)$

(Reddish brown)

* Structural Representation of 3-D molecules on Paper :→

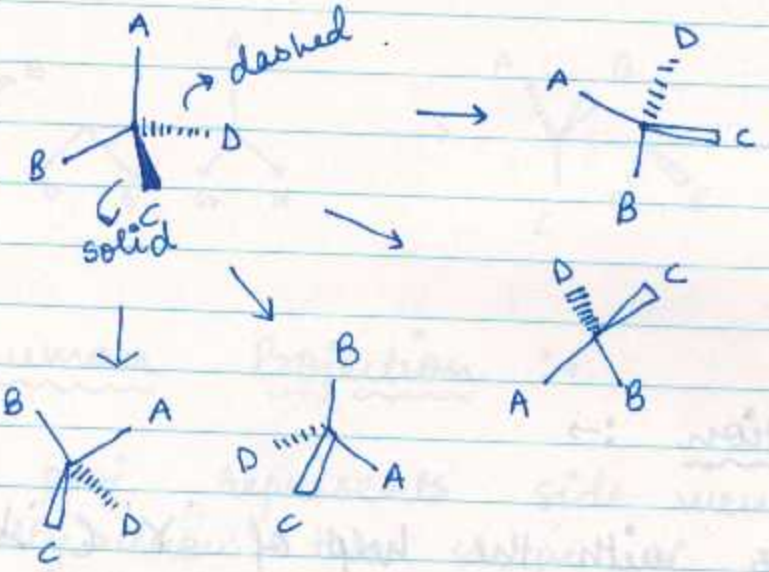
• Representation is significant mainly when hyb. of 'C' is sp^3.

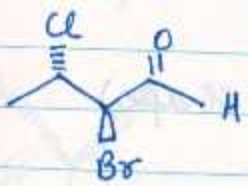
There are various type of representations

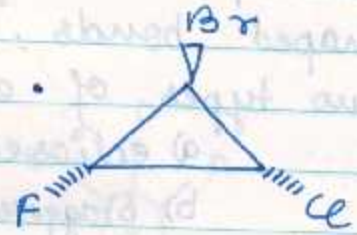
i) Wedge - Dash (Perspective) formula :

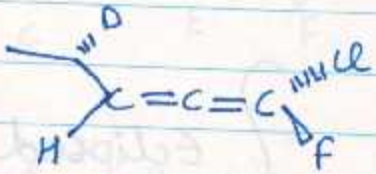
- grps on solid line lie on xy plane, grp at wedge position lie above xy plane i.e. towards the observer, grp at the dash position lies below the plane i.e. away from observer

- A given obj. or molecule can be represented in infinite ways.



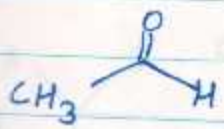






Q. How many atoms can lie on one plane ?

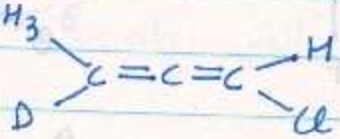
a) CH_4 → 3

b)  → 5

c) C_2H_2 → 4

d) C_2H_4 → 6

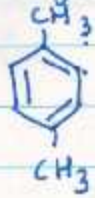
e) $H_3C-C\equiv C-D$ → 5

f)  → 8

g) $D_2C=C=C=CD_2$ → 8

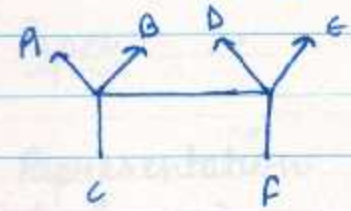
h) → 13

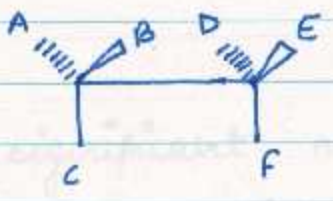
i) p- Xylene

 → 14

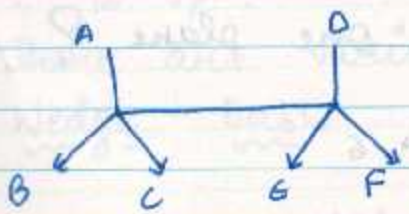
ii) Saw - horse projection :→

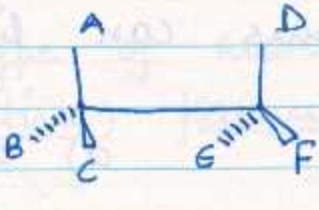
- We represent groups with the help of 'Y' & 'λ' shaped bonds.
- Two types of extreme shapes are possible,
  a) eclipsed : both Y or λ (same shape)
  b) staggered : one Y other λ

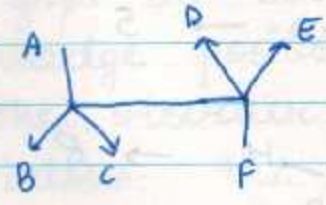


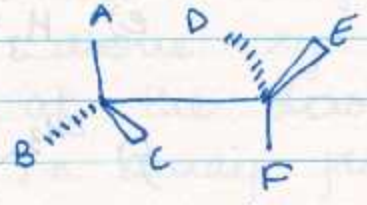


Eclipsed form

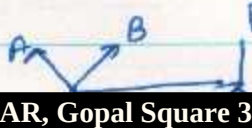


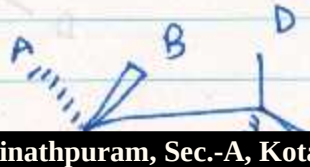






Staggered form





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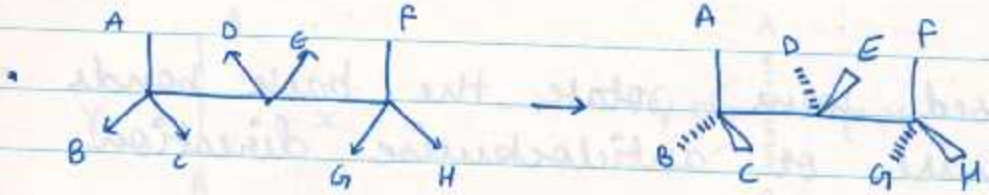
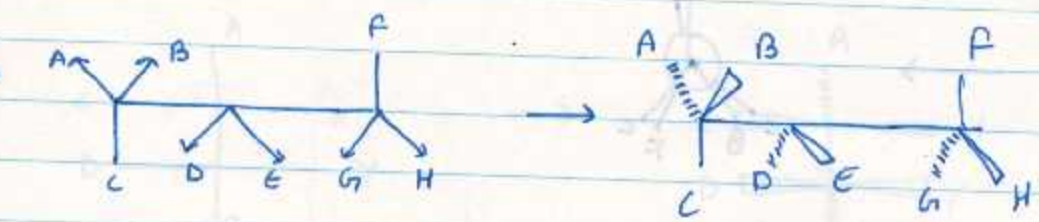
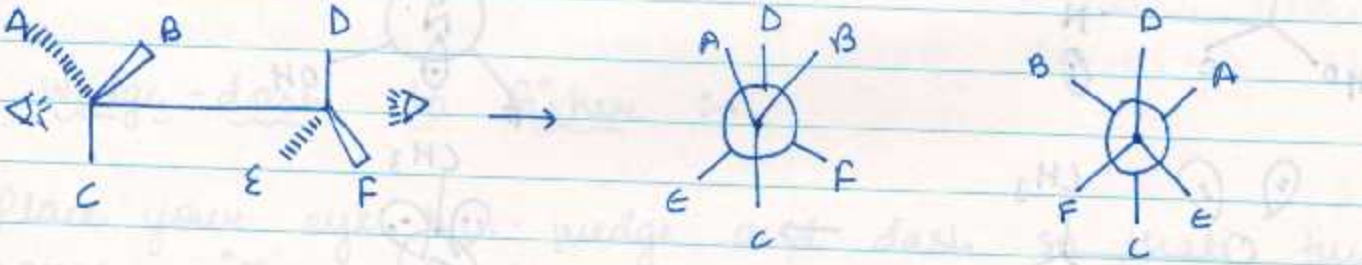


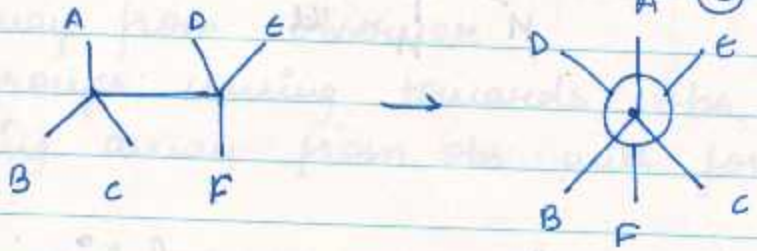


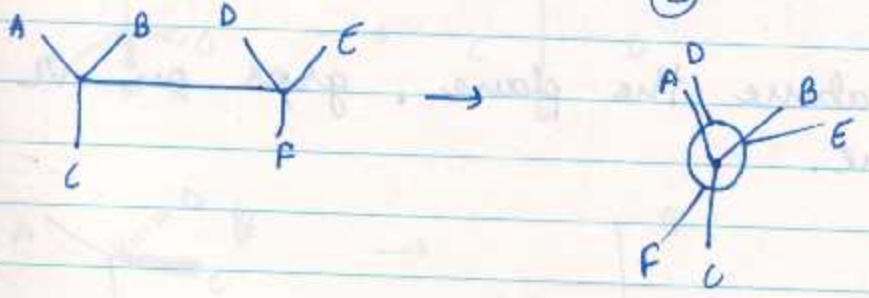
iii) Newman Projection :→

- This proj. represents side view of a molecule.
- Initially draw the shape of front & back bonds and finally insert the groups.



(R)





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In case of eclipsed form, rotate the back bonds slightly in clockwise or anticlockwise direction.

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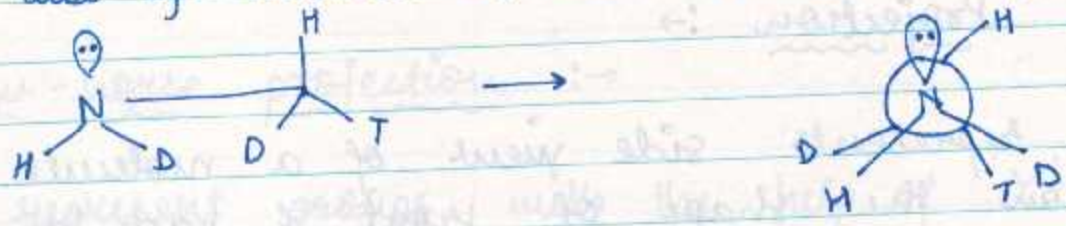
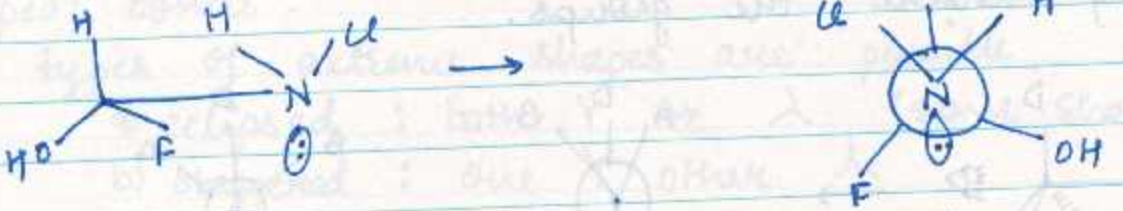
In case of heteroatom, take it as the front atom.

ii)

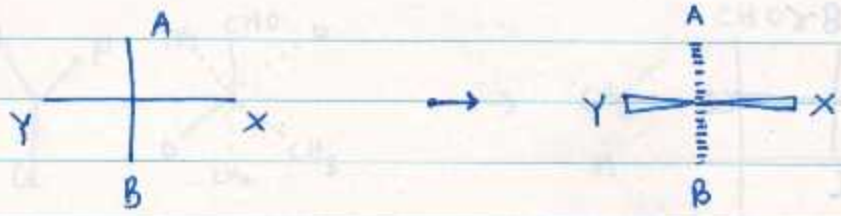




* Fisher Projection :-

- Horizontal lines & vertical lines are used in this prj.
- Grps on HL lie above the plane, grps on VL lie below the plane.

•



H = HUG

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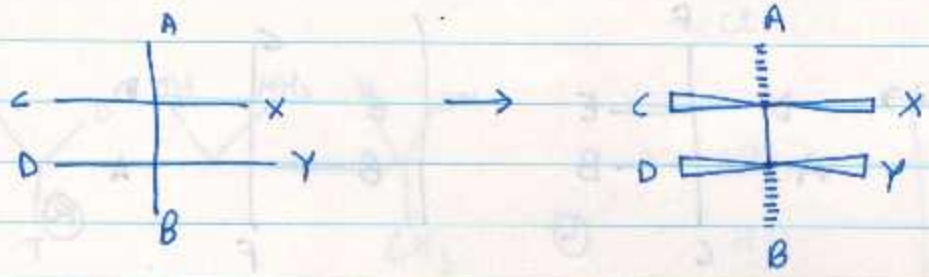

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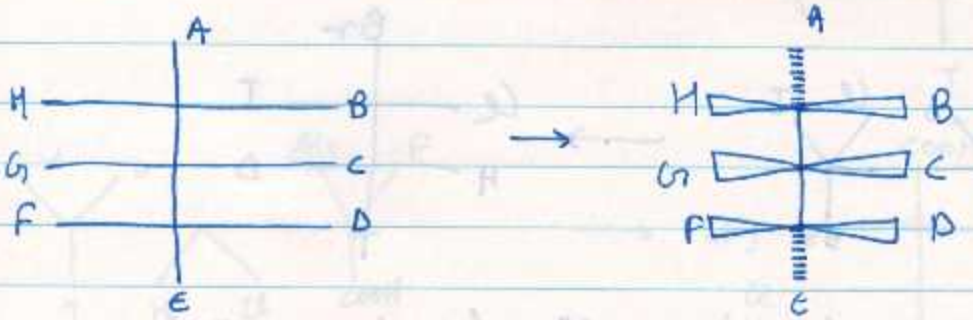

★ Wedge - dash to Fisher :→

- Place your eye b/w wedge and dash so that two groups will come towards the observer and two away from observer.
- Groups coming towards obs. will form HL & grps going away from obs. will form VL.

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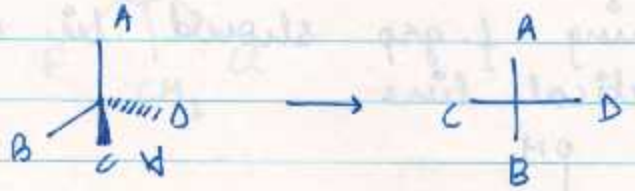

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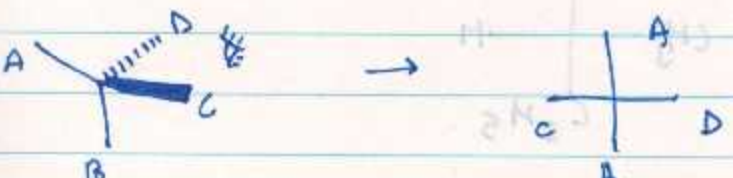
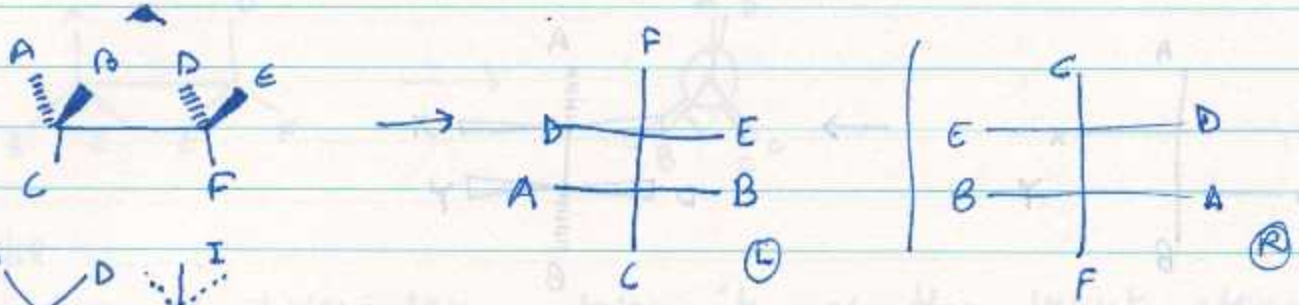
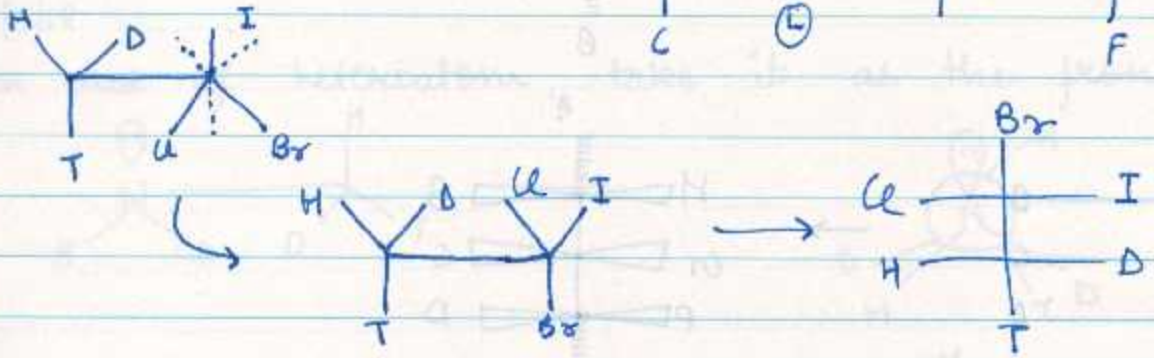
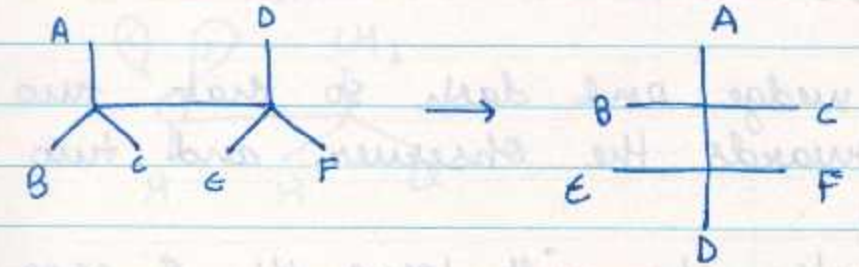




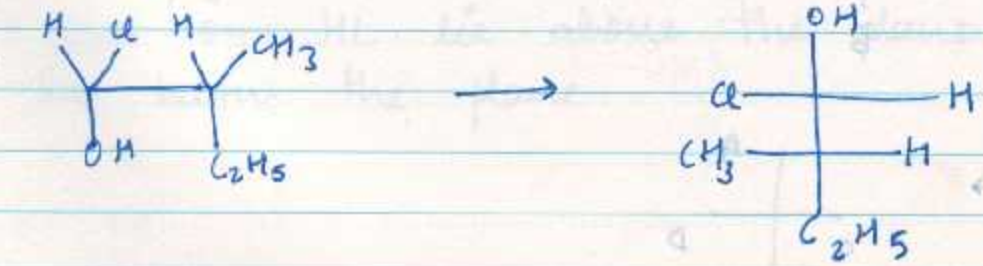


- fisher can be made by eclipsed form only.
  If staggered form is given then rotate accordingly.



★ Golden Rule : i) Max. 'C' should lie on the vertical line.

ii) 'C' containing f. grp. should lie on top of vertical line.



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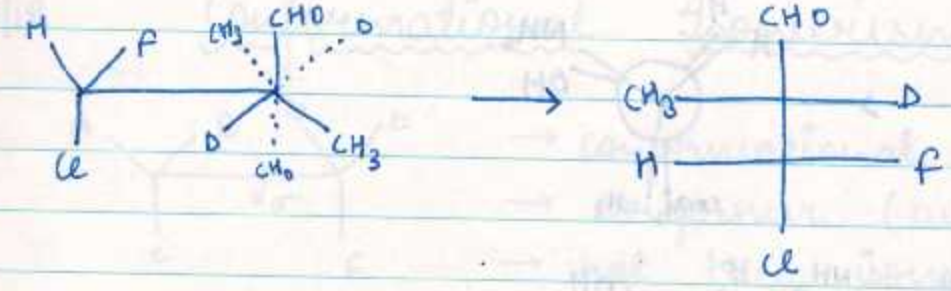

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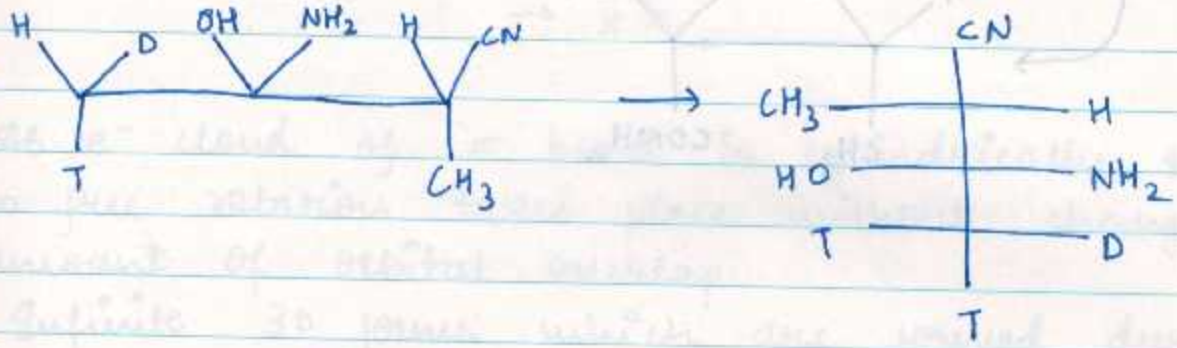

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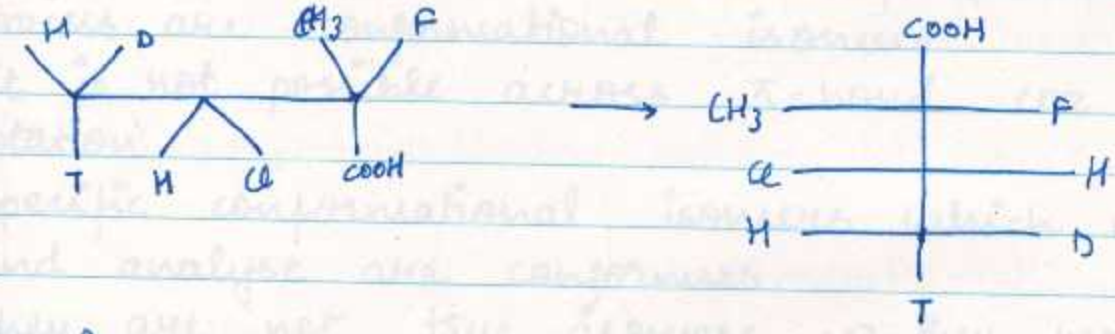

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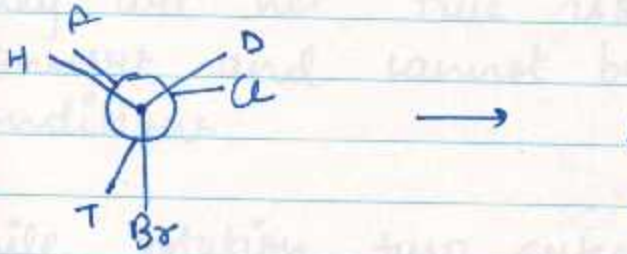

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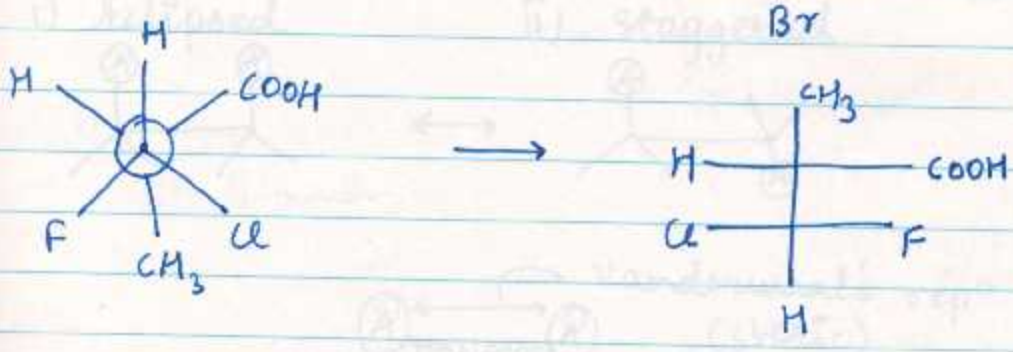

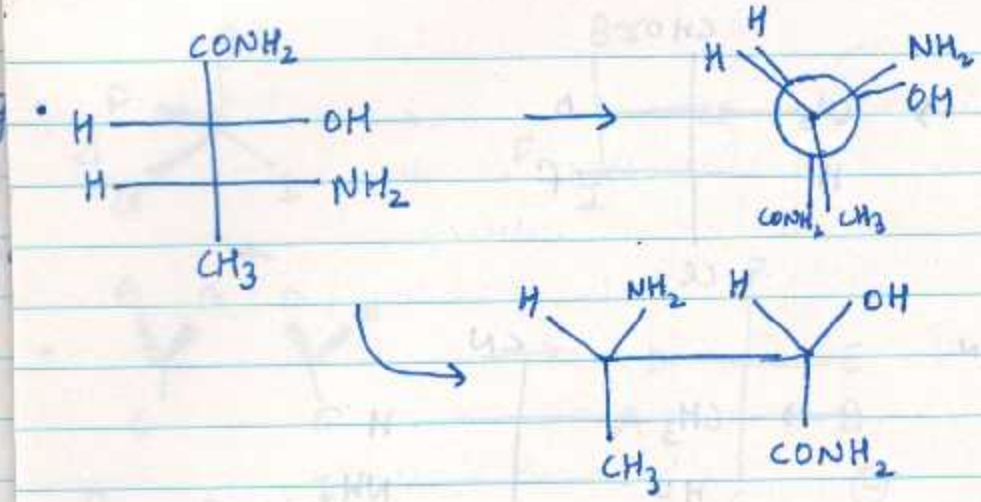
CONH2
H
OH
H
NH2
CH3
H
H
NH2
OH
CONH2
CH3
H
NH2
H
OH
CH3
CONH2

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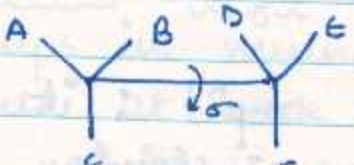
Conformational Isomerism

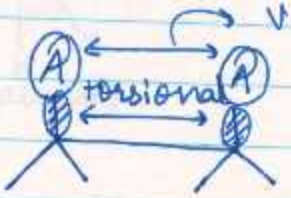


→ conformational isomers (∞)
→ conformer (which we study)
→ not true isomerism
→ × π

- As e⁻ cloud of 'σ' bond is cylindrically symmetric so free rotation takes place without changing amount of orbital overlap.
- Infinite 3D forms which are formed during this process are conformational isomers.
- It is not possible across π-bond coz of restricted rotation.
- Specific conformational isomers which we study and analyse are conformers.
- They are not true isomers coz they readily inter convert and cannot be isolated under normal conditions.

While rotation two extreme forms are obtained

i) Eclipsed ⟷ ii) Staggered



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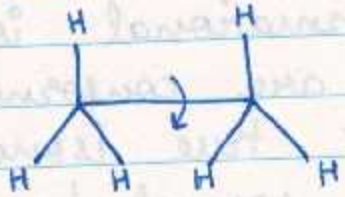
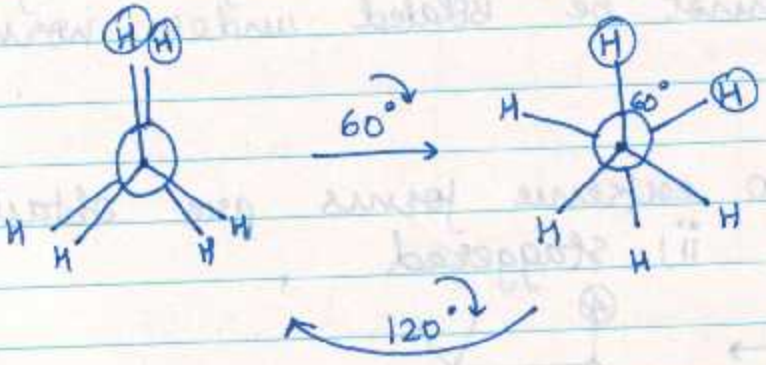
- Eclipsed is less stable than staggered due to two types of repulsions :
  - i) Vanderwaal rep^n (steric rep^n) : it occurs due to rep^n b/w e$^-$ clouds of interacting groups. It is directly proportional to size of group hence it is variable.
  - ii) torsional strain : it occurs due to b.p.-b.p. rep^n. It remains almost constant.

* Conformational Analysis :→

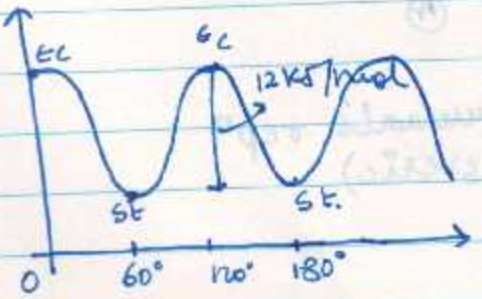
Q. Carry out C.A. of ethane about $C_1 - C_2$ bond rotation.

Ethane → $CH_3 - CH_3$ →





- Torsional strain dominates



Dihedral angle / angle of

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⇒ Dihedral angle : It is the angle b/w two specified groups in newman proj. One at the front & other at back
If nothing is specified then consider the bulkiest groups of front and back.

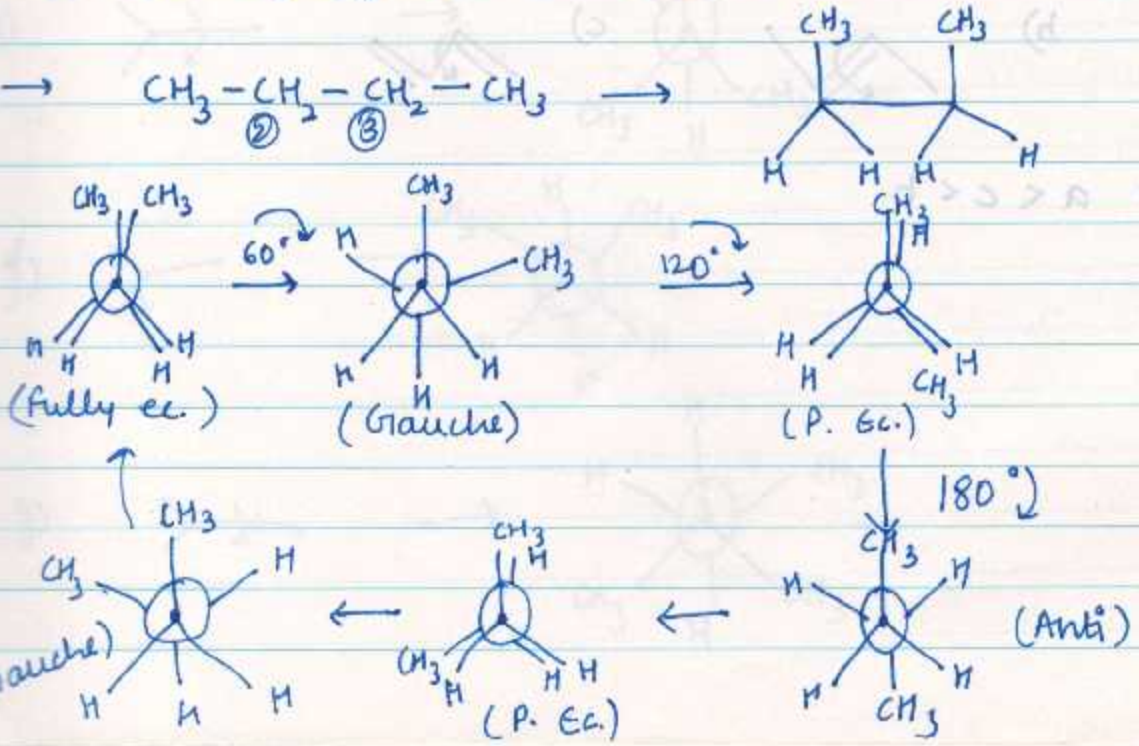
⇒ Rotational / Energy Barrier : It is amt. of energy needed for rotation across a given bond for one mole of a compound.

*// Energy available at R.T. is 84 KJ/mol

- In P.E curve it is the difference b/w maxima & minima.
- It is energy diff. b/w least stable & most stable conformer.

Q. carry out conformational analysis of n-butane about C_2-C_3 bond rotation

→ $CH_3-\overset{②}{CH_2}-\overset{③}{CH_2}-CH_3$ →



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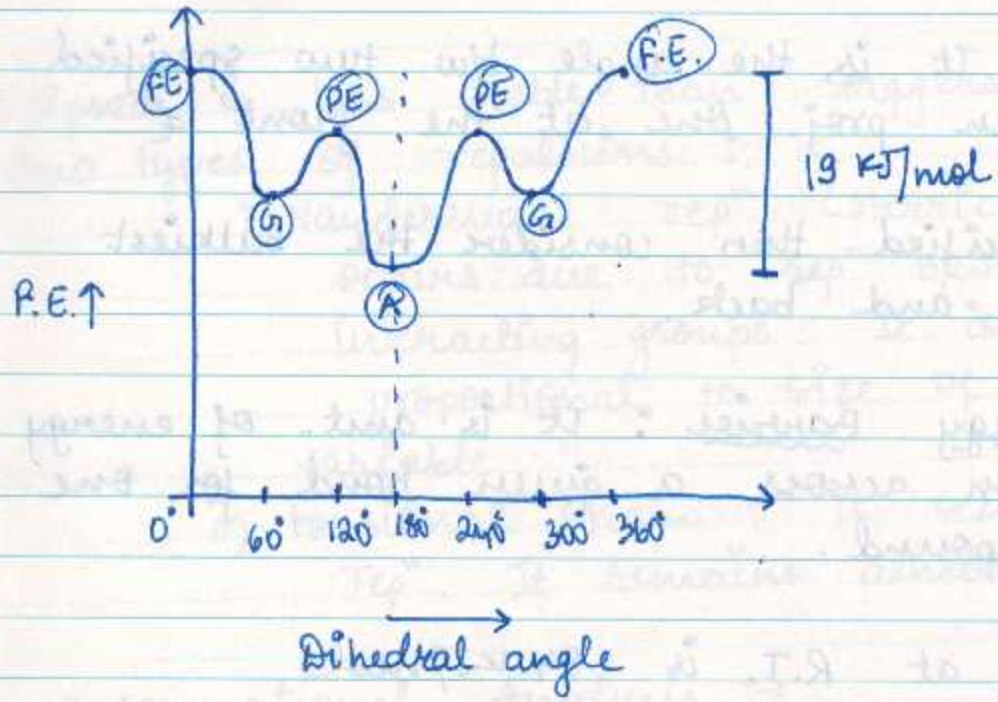

Q. compare Rotational Barrier

1) a) b) c)

$\Rightarrow c < a < b$

2) a) b) c)

$\Rightarrow a < c < b$

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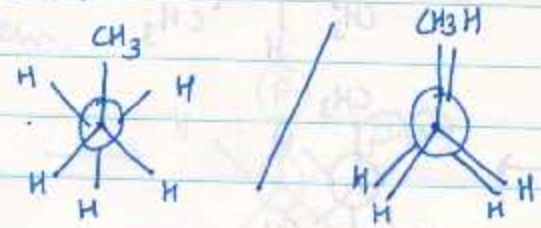
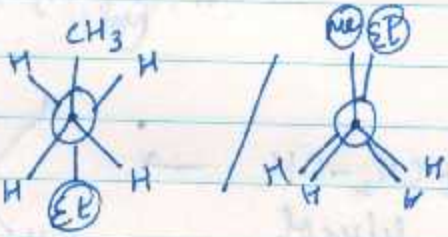
Q. Draw the most and least stable conformer in the following cases :→

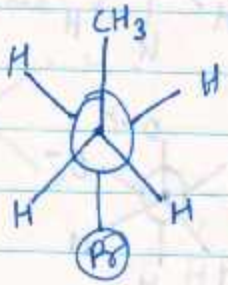
a) $CH_3-CH_2-CH_3$ →



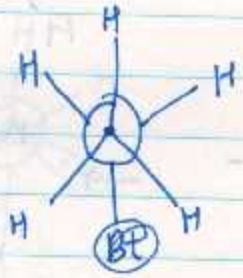
b) $CH_3-CH_2-CH_2-CH_2-CH_3$ → n-pentane

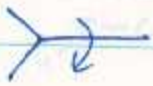


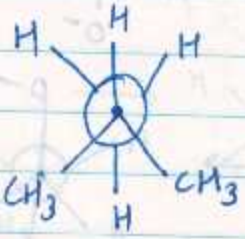
c) →



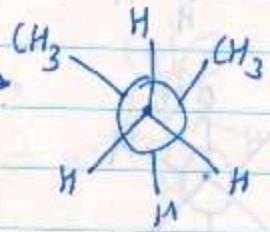
d) $CH_3-(CH_2)_4-CH_3$ →



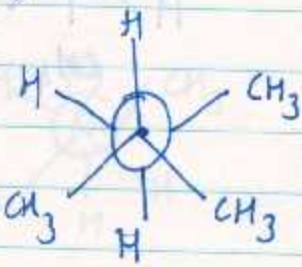
e)  →



f) →



g) →



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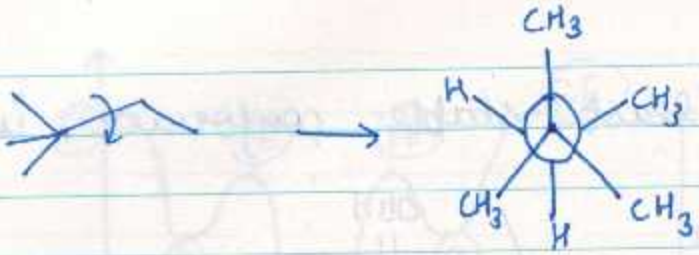
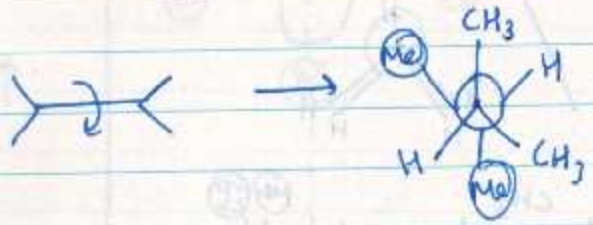
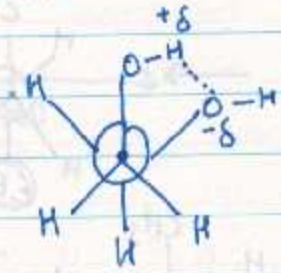
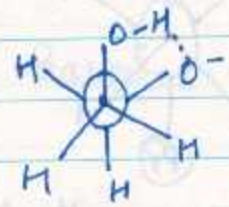
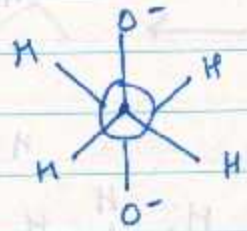
h) 

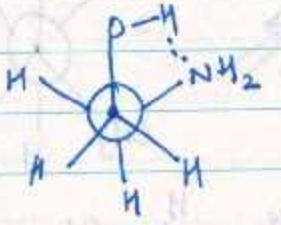
i) 

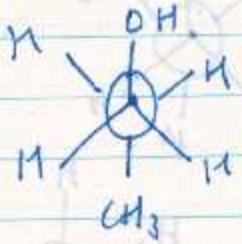
j) $HO-CH_2-CH_2-OH$ Ethylene glycol → 

Gauche is more stable due to H-bonding. {In gaseous medium}

k) $HO-CH_2-CH_2-O^-$ → 

l) $O^--CH_2-CH_2-O^-$ → 

m) $HO-CH_2-CH_2-NH_2$ → 

n) $HO-CH_2-CH_2-CH_3$ → 

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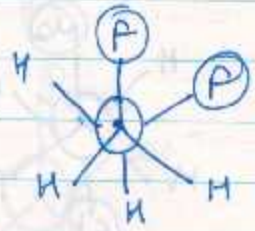
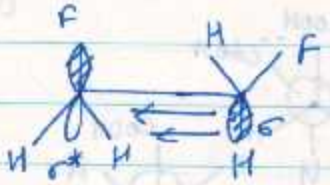
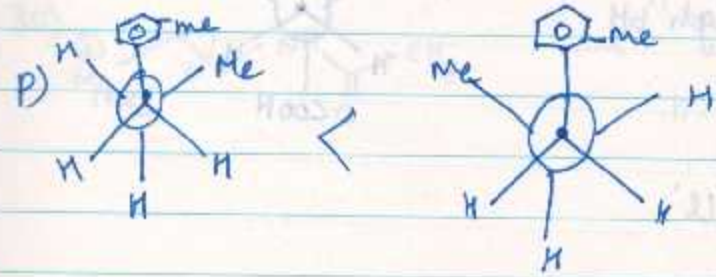
* Gauche Effect : It is unusual stability of gauche form when highly EN atom such as 'F' are present on two carbon system.

o) $F-CH_2 \rightleftharpoons CH_2-F$ ⟶

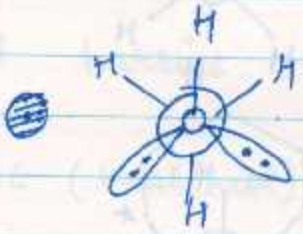




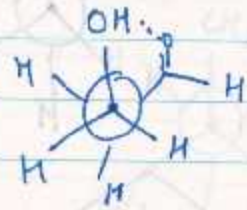
p)



q) $CH_3 \rightleftharpoons OH$ ⟶

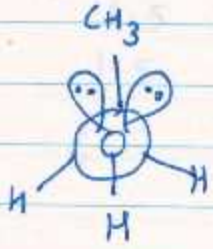


r) $H-O-CH_2 \rightleftharpoons CH_2-C(=O)-H$ ⟶

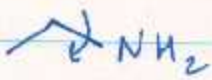


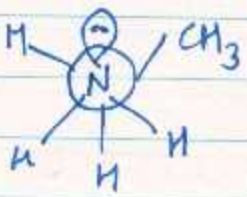
Chelation.

s) ⟶



★ l.p. is considered to be least crowded

t)  ⟶



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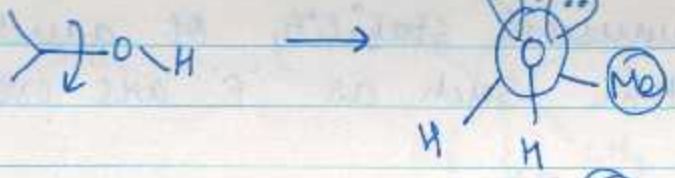
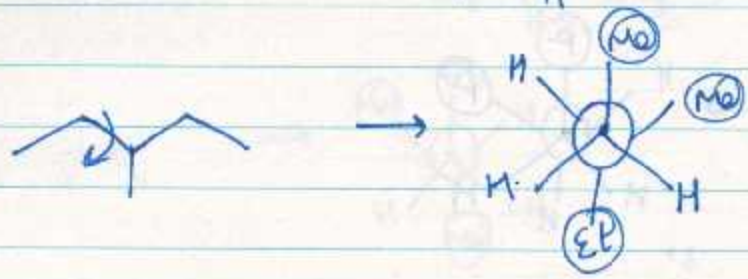
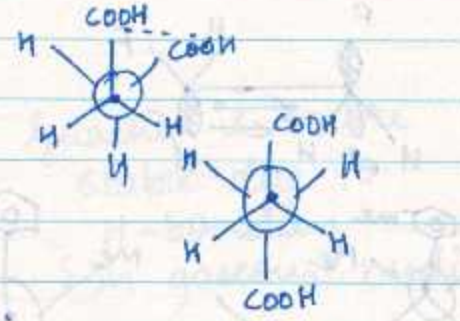
h) u)



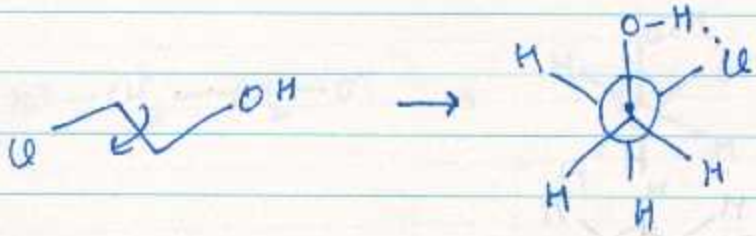
i) v)



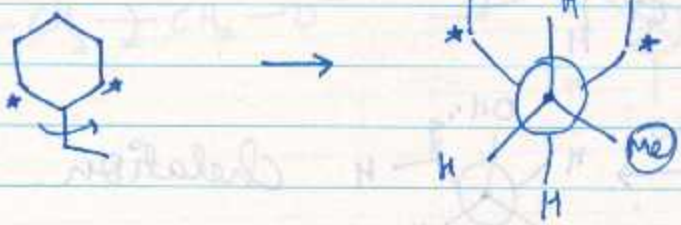
j) w) $HOOC-CH_2 \rightleftharpoons CH_2-COOH$ → low pH, → high pH



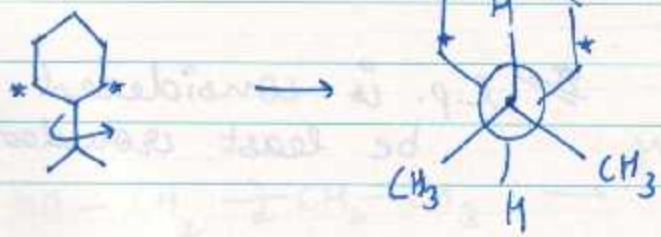
x)



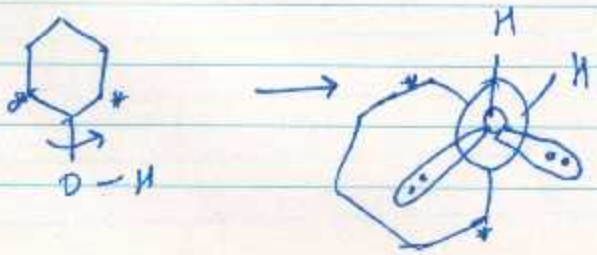
y)



z)



z1)



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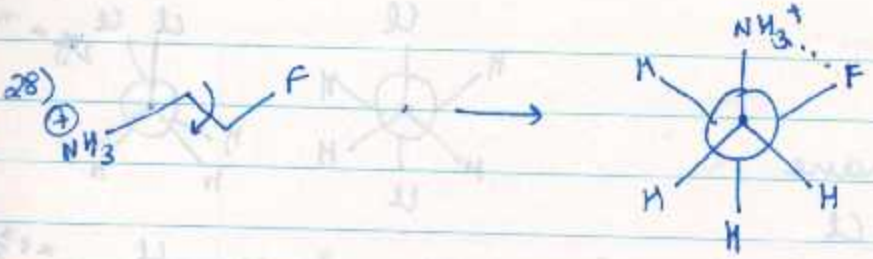
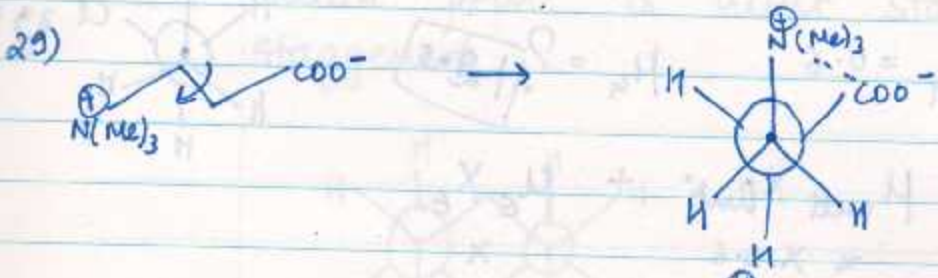
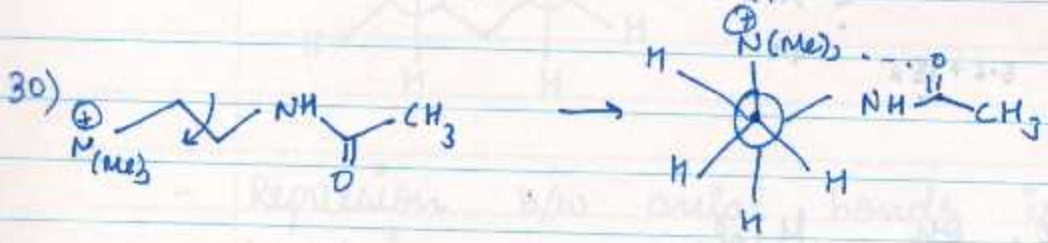
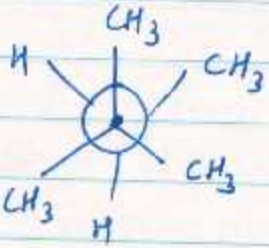
28) 

29) 

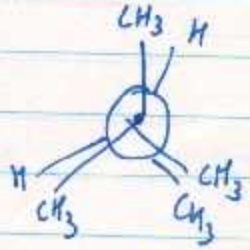
30) 

Q. Calculate Rotational barrier = 5.5

Interac^n	ΔE (kcal/mol)
H, H (G)	0
H, H (E)	1
CH_3, H (G)	1
CH_3, H (E)	1.5
CH_3, CH_3 (G)	1.5
CH_3, CH_3 (E)	6



3.5



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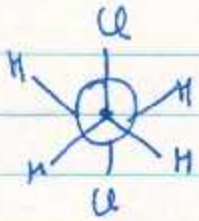
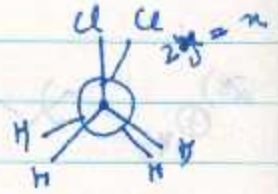



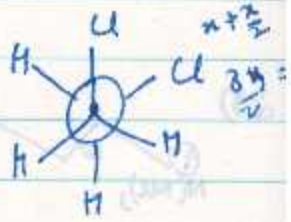
Q. dipole moment

1,2 - dichloro ethane

$Cl-CH_2-CH_2-Cl$

$\mu_{sol} = \Sigma \mu_i X_i$

$\mu_{sol} = 5D$ $\quad X_{anti} = 0.6$ $\quad \mu_G = ?$ 12.5



$\longrightarrow \quad 5D = \mu_S X_S + \mu_{anti} X_{anti} + \mu_E X_E$

$x \times 0.6$ $\quad x$

$0.6 + \frac{18}{4} x$ $\quad 4.8$

Q. Effect of temp. on μ_{sol}.

4/4/18

* Conformations of cyclohexane :→

It exists in many forms but chair form is most stable.

- Two types of C-H bonds are present in chair form

  i) Axial : They are ⊥el to y-axis. They are successively up and down.

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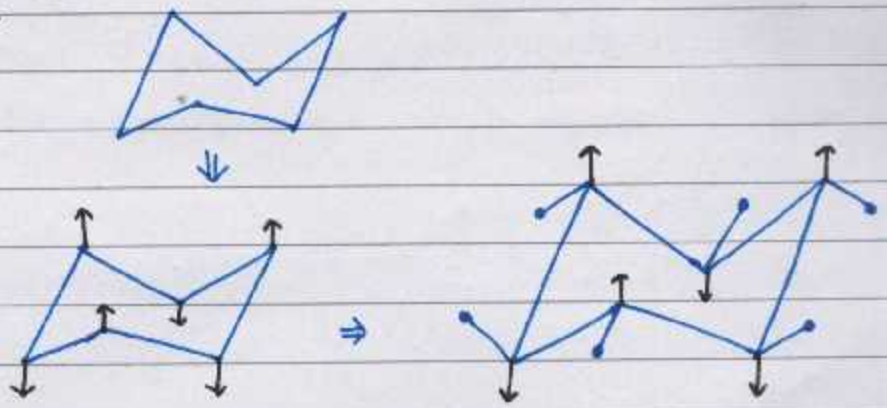
...al : Each eq. bond is parallel to ring bond after t... 'C' atoms.

- Axial
- Equitoria



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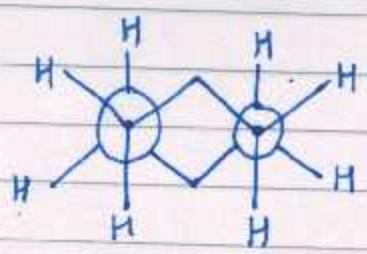
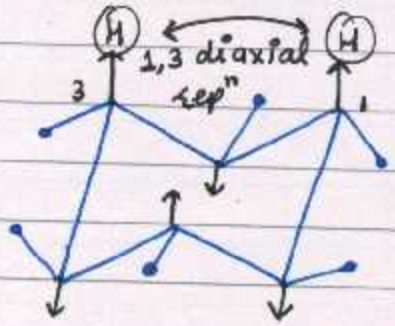
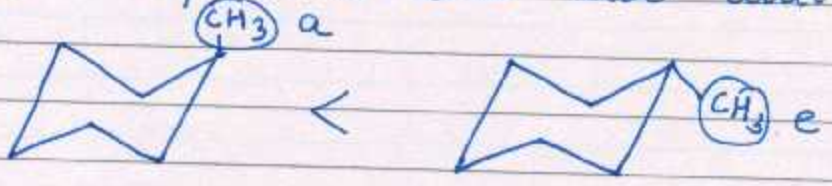
- Chair form is most stable coz it is staggered.



- Repulsion b/w axial bonds is 1,3-diaxial repulsion.



- A substituent is generally more stable at equitorial position because of lesser repulsions and also anti form



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- cis - trans in chair form

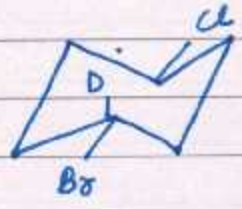
F - Cl → (T)
F - Br → (C)
Br - Cl → (T)

1)

⇒ Cl - Cl → (T)

2)

⇒ OH - Cl → (T)
OH - Br → (C)
Br - Cl → (T)

3) 

⇒ D - Br → (T) ✗ {as they are on same atom}
D - Cl → (C)
Cl - Br → (T)

Q. Compare Stability

(a)

(b)

(c)

(d)

⇒ a > d > c > b

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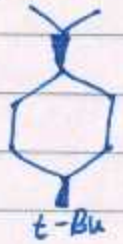
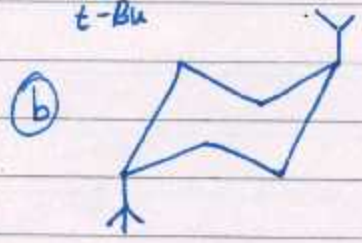
Q. Identify the most stable form of given compound.

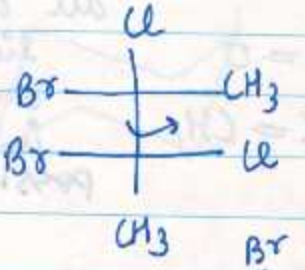


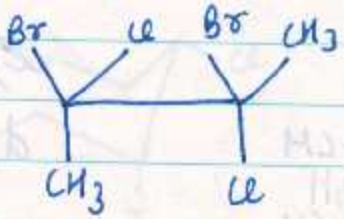


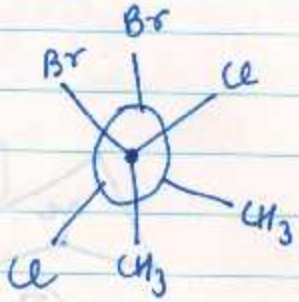
⇒ a > c > d > b ~~×~~ (c) coz a & b are not of given compound.

In case of choice, put the bulkier group at eq. position

Q. How many stable conformers of the given compound having non zero dipole moment are possible.

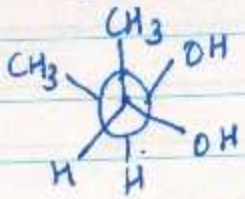


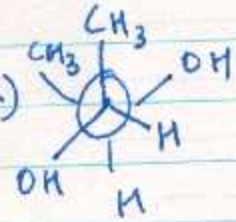


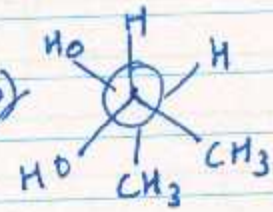


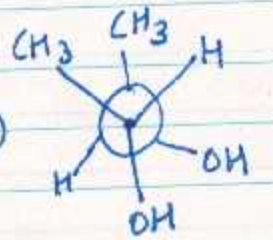
(3)

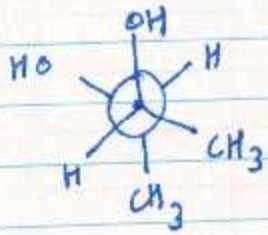
Q. Which of the following represents same cmpd. as given conformer ?

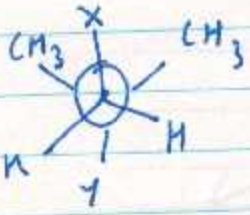


a) 

b) 

c) 

d) 

Q. 

For 2, 2 dimethyl butane x & y can be

a) H, H b) H, Et c) Et, H d) CH_3, CH_3

Q. a)

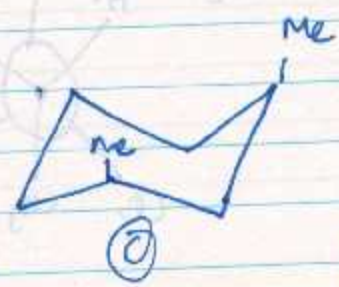
b) $H-C\equiv C-CH=CH_2$

c) $CH_2=C=O$

d) $CH_2=C=CH_2$

In which cmpd(s) all atoms lie in one plane in all possible conf^n

Q.



d > a = b > c

ab) A
ac) GI
ad) GI
bc) GI
ba) A
bd) GI

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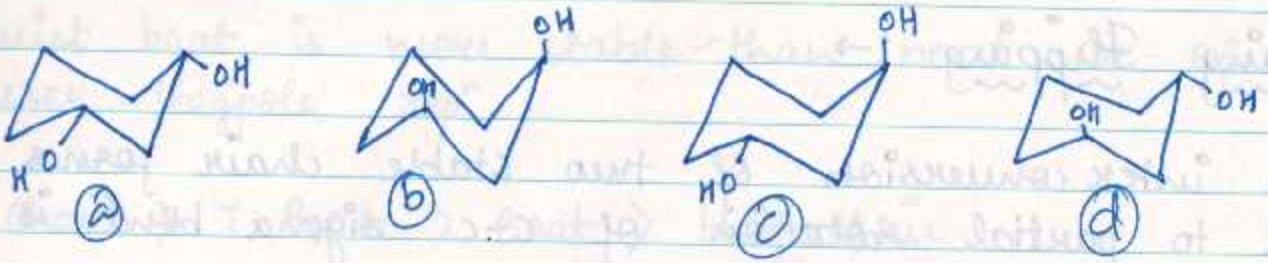
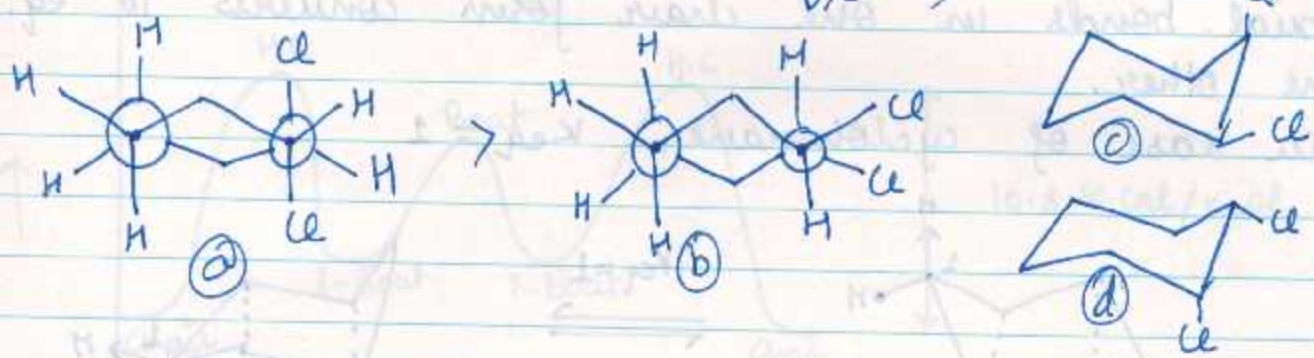
Q.6



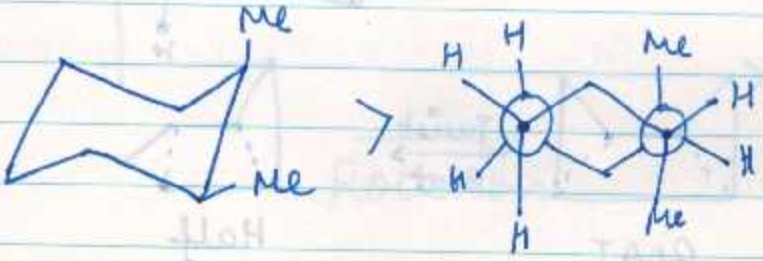
b>a> c=d

Q.7.

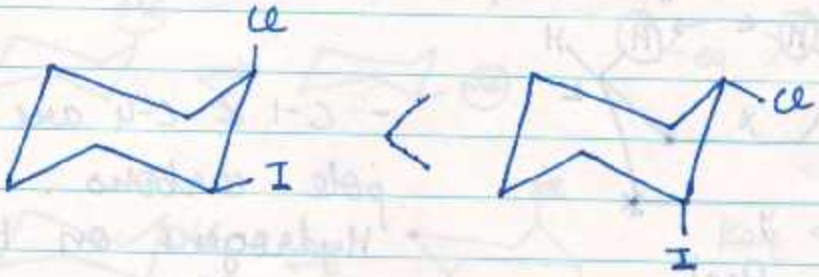
b>c=d>a



Q.8.

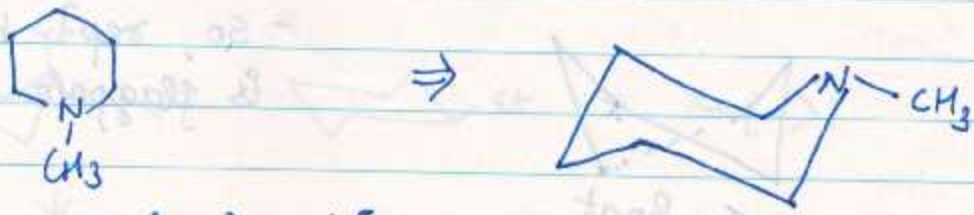


Q9.



when we move from F → Cl repⁿ ↑ but then ↓ coz of more B.L. in case of Br/I & thus interaction with H will be less

Q10.



N-methyl piperidine

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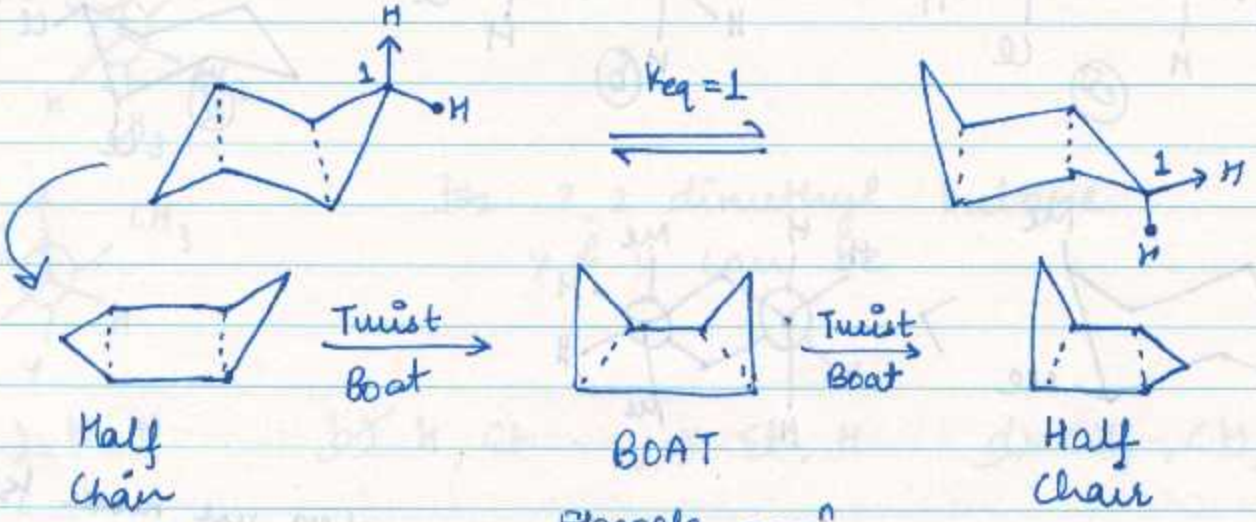
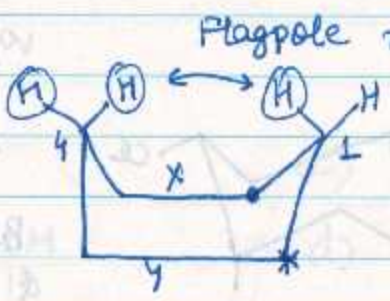
* Ring Flipping :→

- The inter conversion of two stable chair forms due to partial rotation of C-C sigma bond is known as flipping.
- It is very fast coz energy required for flipping is easily available.
- Axial bonds in one chair form converts to eq. in the other.
- In case of cyclohexane, $K_{eq} = 1$





- C-1 & C-4 are flag pole carbons.
- Hydrogens on them are FP-H
- So, repⁿ b/w them is flagpole repⁿ

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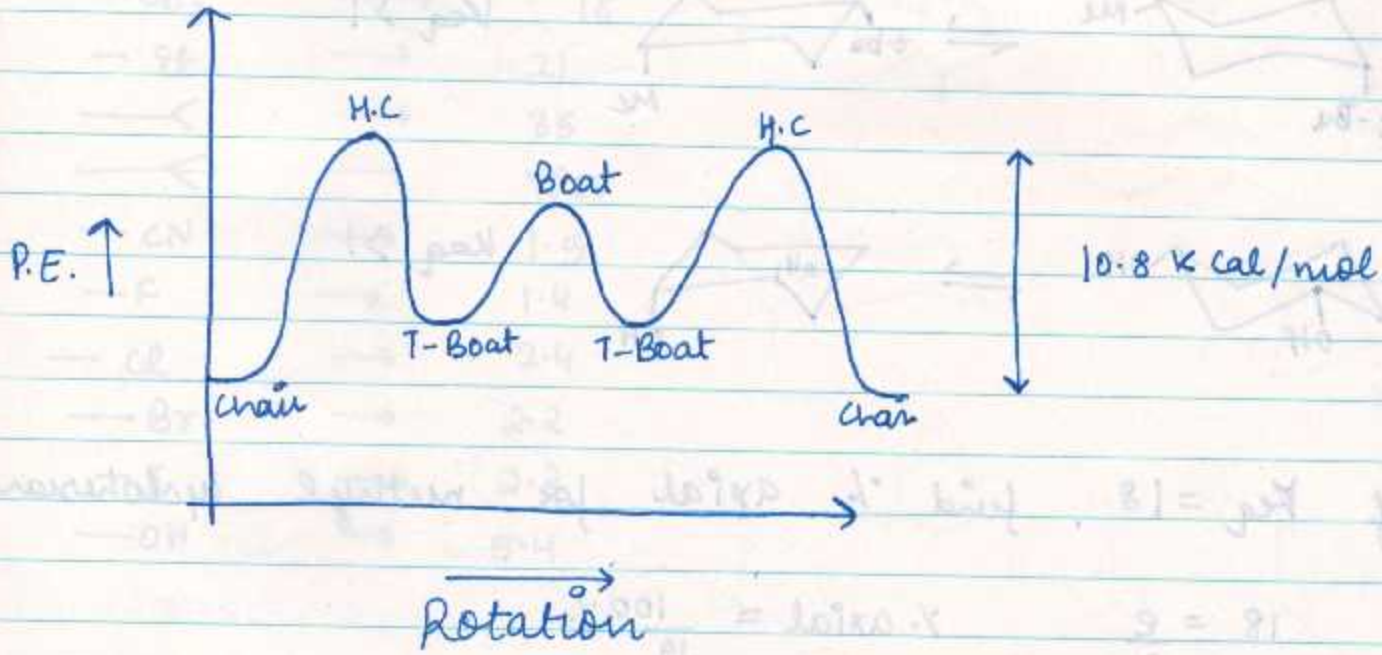
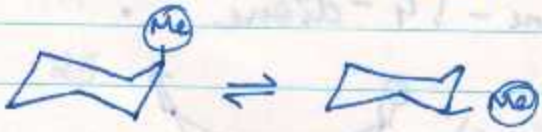
- Twist boat is more stable than boat coz of lesser flagpole repⁿ.

Chair > T-Boat > Boat > Half Chair

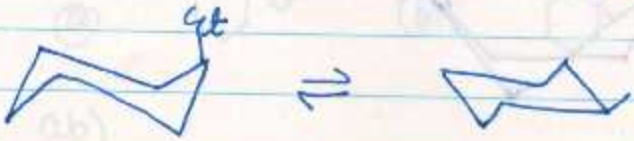
{Stability Order}



g. Comment on K_{eq}.

1]  $K_{eq} > 1$

2] $K_{eq} < 1$

3]  $K_{eq} > 1$

4] $K_{eq} > 1$

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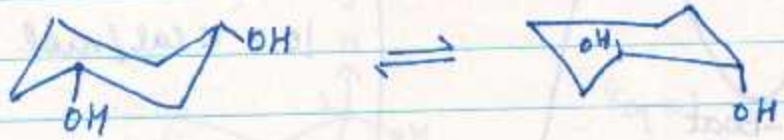
chap. 1

5] $K_{eq} > 1$

6] $K_{eq} = 1$

7] $K_{eq} > 1$

8]  $K_{eq} > 1$

9] If $K_{eq} = 18$, find % axial for methyl cyclohexane.

$\longrightarrow \quad 18 = \frac{e}{a} \qquad \%\ axial = \frac{100}{19}\ \%$

10] Dipole moment in cyclohexane-1,4-dione :

a) b) c)

d) e)

Non-zero d.m.

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•)

(X)

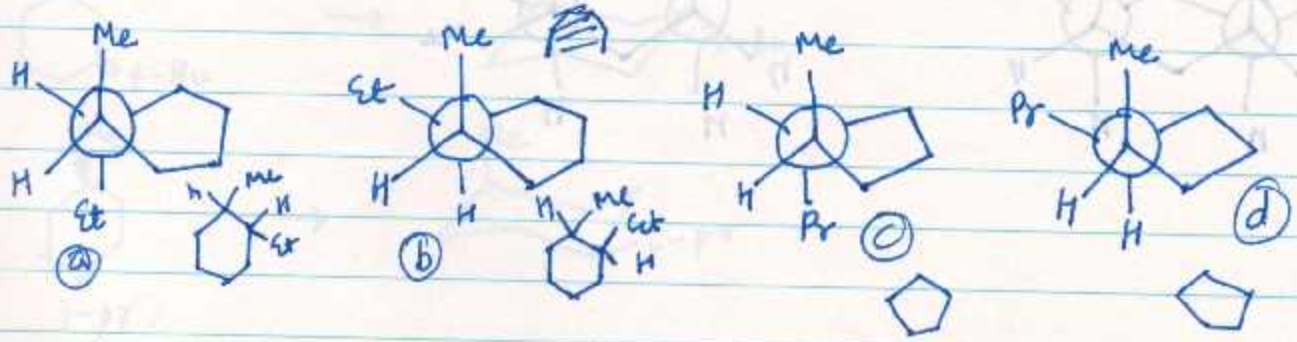
$K_{eq} = \frac{e}{a}$

$-H$	→	1
$-CH_3$	→	18
$-Et$	→	21
—≺	→	35
—≺	→	4800
$-CN$	→	1.5
$-F$	→	1.4
$-Cl$	→	2.4
$-Br$	→	2.2
$-I$	→	2.2
$-OH$	→	5.4

ii] $\mu_{sol} = 5D$ $\chi_{chair} = 0.8$ $\mu_{T.B.} = ?$

→ 25

iii]



ab)

ac)

ad)

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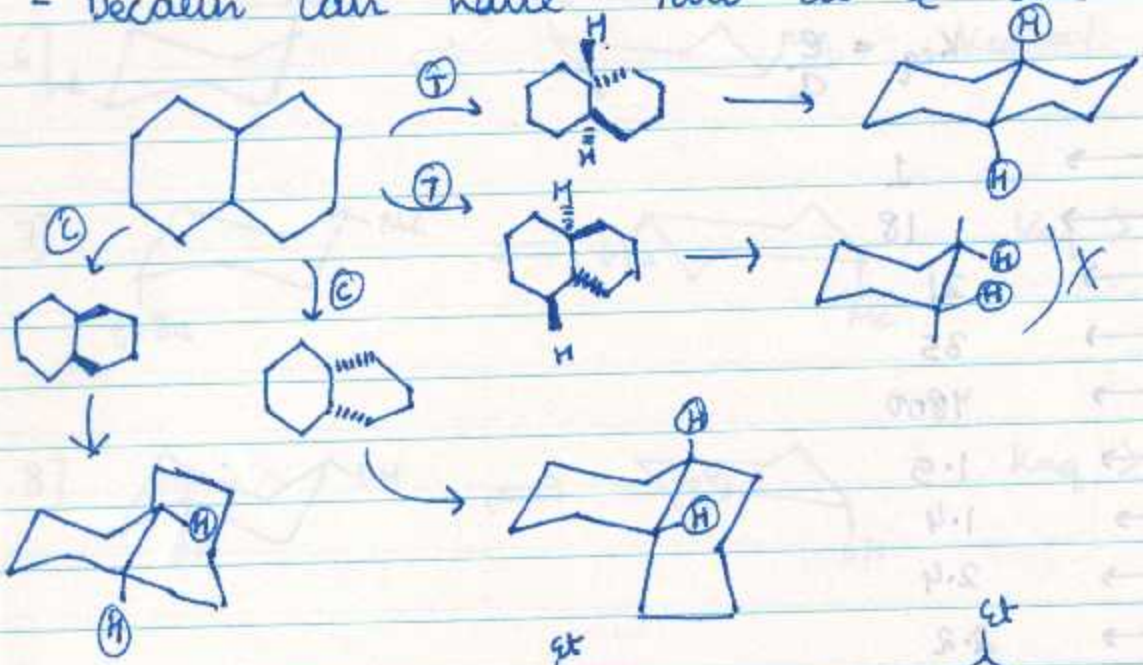
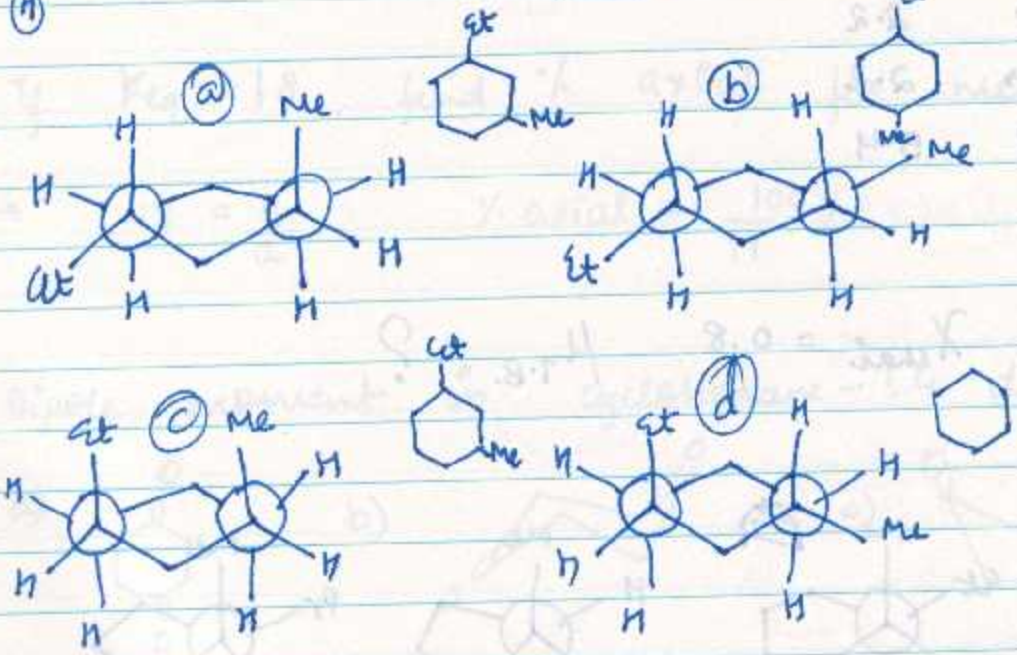
* Special case of DECALIN :→

- Decalin can have two cis & one trans form.



13]



ab) P.I.
ac) G.I.
ad) conf.
bc) P.I.
bd) P.I.
cd) G.I.

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Q. Draw most stable form

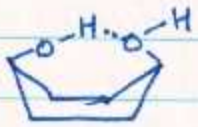
1] Cis -1,3 - dimethyl cyclohexane

2] Trans -1,3- dimethyl cyclohexane

3] Cyclohexane - 1,3-diol

**4] Cyclohexane - 1,4-diol

Boat form



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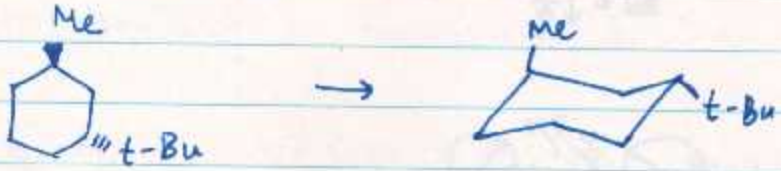

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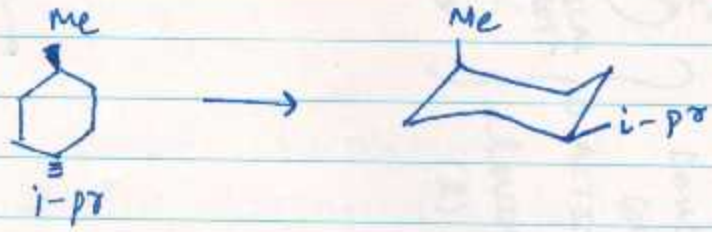

7)

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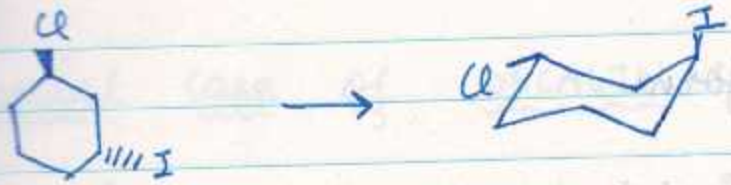

Cis - 1,4 - di tert. butyl cyclohexane

H.W.
Set - 1, 2, 3

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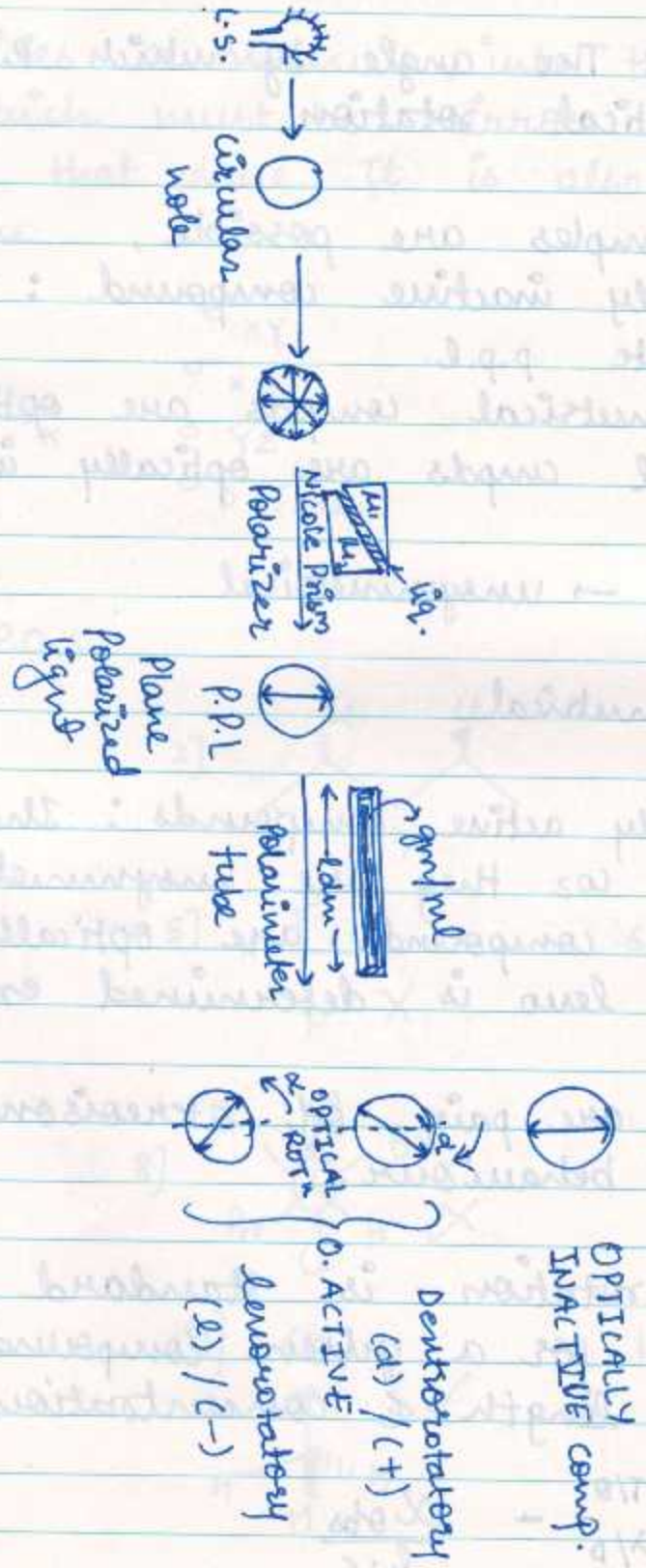
Optical Isomerism

* Polarimeter experiment :



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• Aim :

- To check the optical activity of the given substance.

• Optical Rotation : The angle by which P.P.L rotates is known as optical rotation.

• Two type of samples are possible,

i] Optically inactive compound : It fails to rotate p.p.l.
Symmetrical compds are optically inactive.
Achiral cmpds are optically inactive.

* Chiral → Cheir (hand) → unsymmetrical

Achiral → symmetrical

ii] Optically active compounds : They rotate the p.p.l. coz they are unsymmetrical.
Chiral compounds are optically active.
- Dextro & levo is determined experimentally.

• Optical isomers are pair of stereoisomers having different optical behaviour.

• Specific optical rotation is standard value of optical rotation for a given compound which is independent of length & concentration.

$$[\alpha]^{T/0}_{\lambda/D} = \frac{\alpha_{obs}}{l \cdot c}$$

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* Elements of Symmetry :

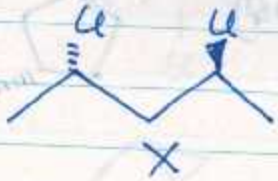
1. Plane of Symmetry / P.O.S. / (σ)

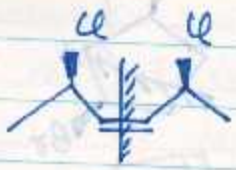
- P.O.S divides a molecule into two identical halves which must be mirror images of each other about that plane. It is also known as mirror plane.

σ_{XY}
σ_{XZ}
σ_{YZ}
σ_D (skew)

Q. Identify P.O.S.

1]

2] 

3] 

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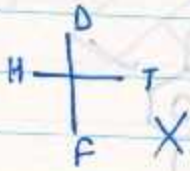
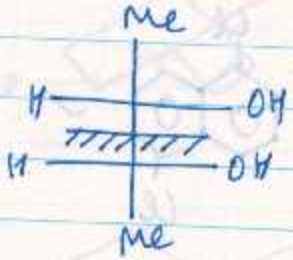
5] 

6] 

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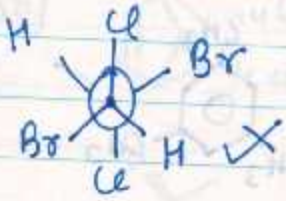
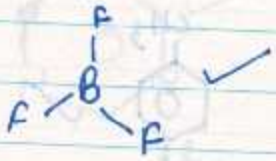
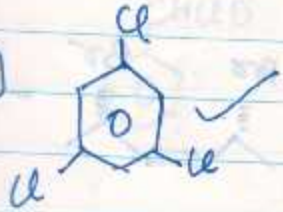
8] 

9] 

10] 

11] CH_4 ✓

12] Hockey stick

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13] Scissor ✗

14) Helical structure ✗

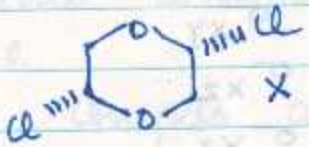
15] DNA Helix ✗

16] Natural rubber ✗

17] PCl_5 ✓

18) CH_2Cl_2 ✓

19] ClFeBrI ✗

20]  ✗

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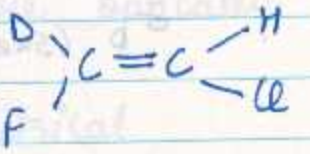
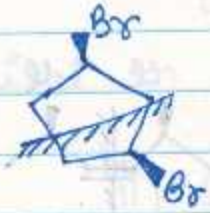
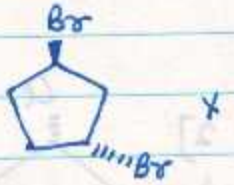
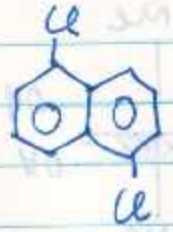
22]  ✓

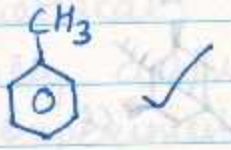
23] 

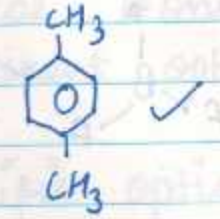
24]  ✗

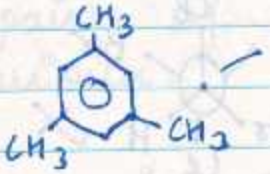
25] ✓

26]  ✓

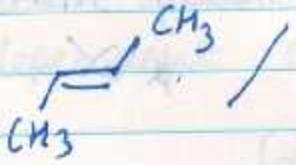
27] ✓

28]  ✓

29]  ✓

30]  ✓

31] ✓

32]  ✓

33]

34] ✓

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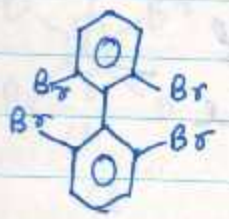
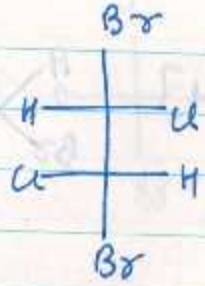
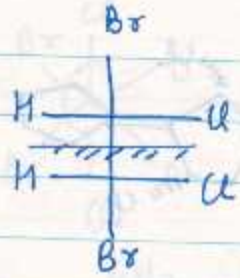
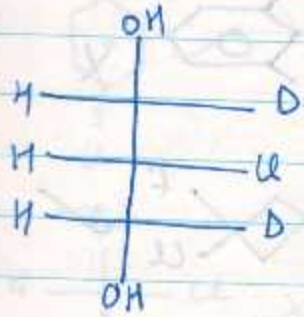
35] 

36] 

37] 

38] 

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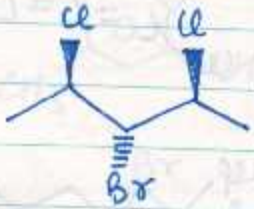
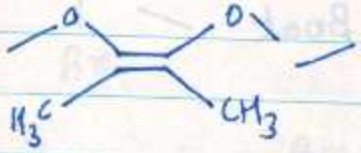
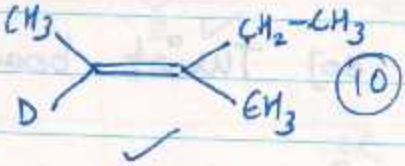
40] 

41] 

42] 

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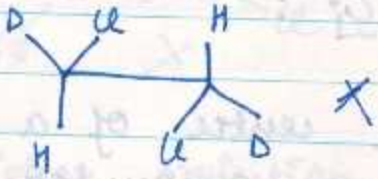
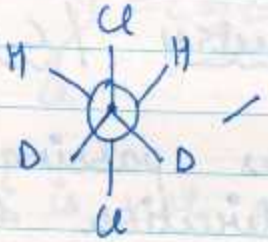
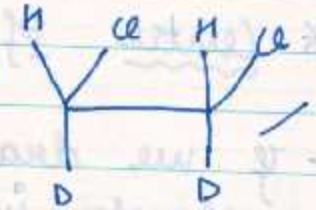
43] 

44] 

45] 

46]

47]

48]

49]

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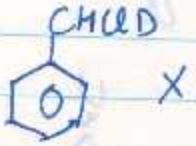
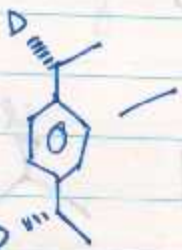
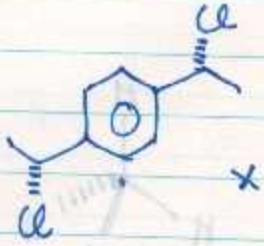
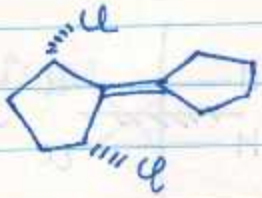
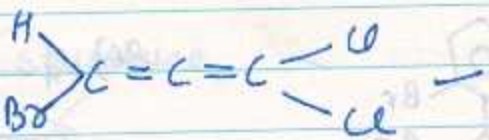
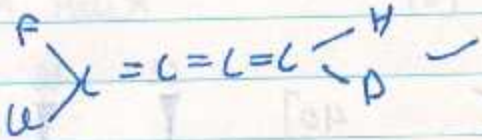
51] 

52] 

53] 

54]  ✓

54]  —

55]  —

56] X

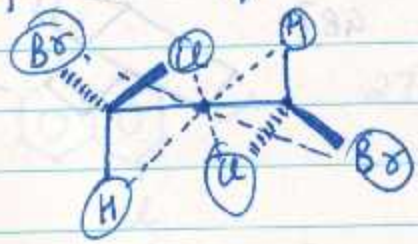
57] ✓

58] ✓

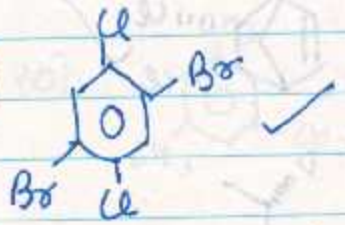
59] Chair ✓ 60] Twist boat + 61] Boat —

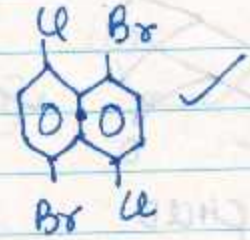
* Centre of Symmetry / C.O.S / Ci :

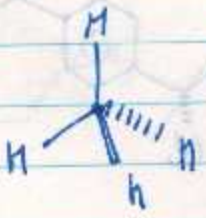
- If we draw lines passing thru centre of a molecule in any direction & if we encounter same groups at equal distances then C.O.S. is present

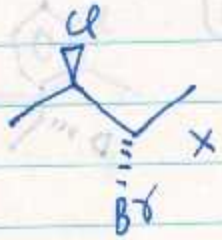


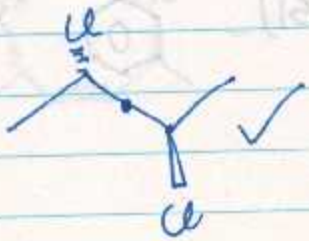
1] ✓

2]  ✓

3]  ✓

4]  X

5]  X

6]  ✓

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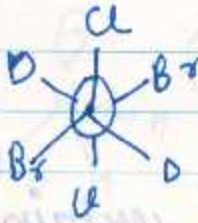
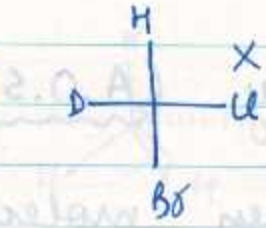
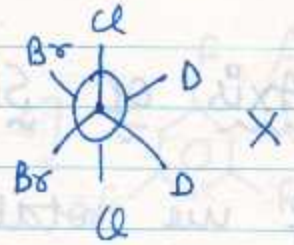
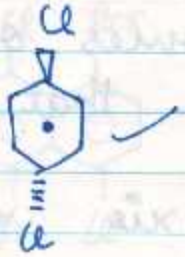
7]  ✓

8] 

9] 

10] 

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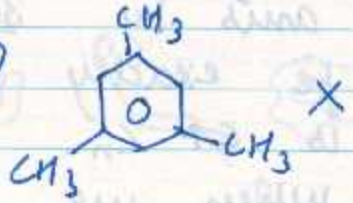
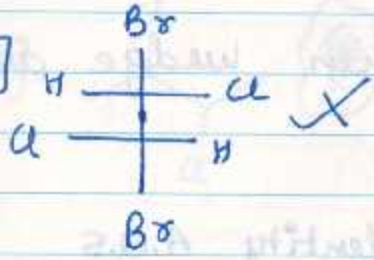
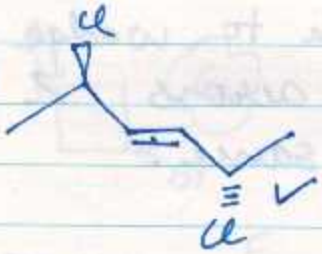
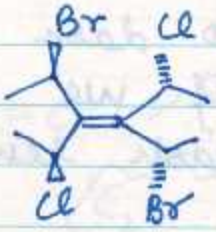
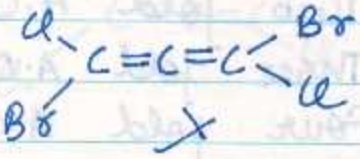
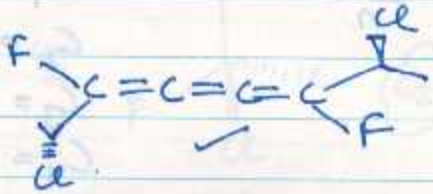
12] 

13] 

14] 

15] 

16] 

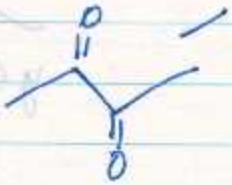
17] 

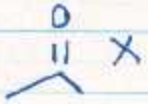
• in fisher projection, C.O.S is not possible

18]

19]

20]

21] 

22] 

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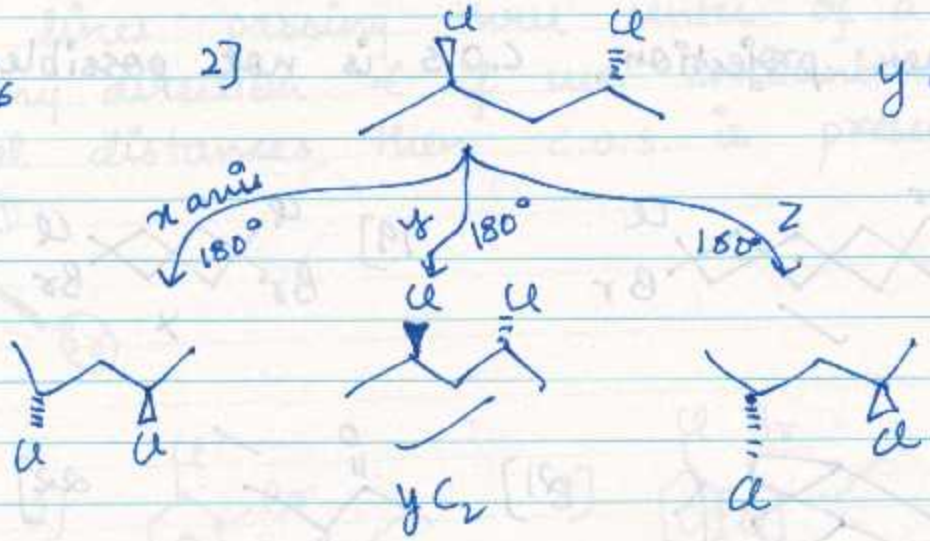
* Axis of Symmetry (A.O.S) :

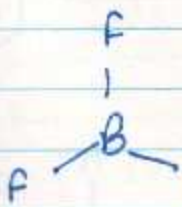
- If we rotate a given molecule about certain axis by $\frac{360^\circ}{n}$ and the molecule comes out to be exactly same as before then that axis is $\Leftrightarrow C_n$.
- When we rotate across X or Y axis wedge to dash & dash to wedge
- If we rotate across Z axis then wedge and dash remains same.

$C_n = \frac{360^\circ}{n}$

$C_1 = 360^\circ$	Identity A.O.S
$C_2 = 180^\circ$	Two fold A.O.S
$C_3 = 120^\circ$	Three fold A.O.S
$C_4 = 90^\circ$	Four fold A.O.S

1] $Z C_6$

2] 

3] 

$\Rightarrow Z C_3$
$y C_2$

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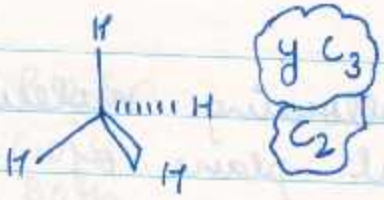
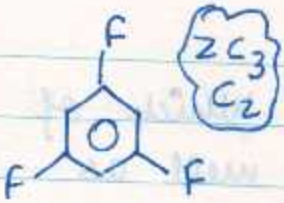
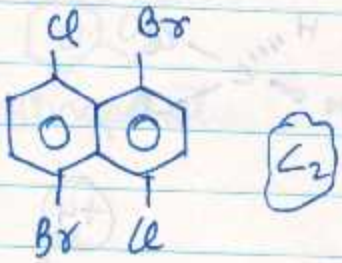
4] C_3

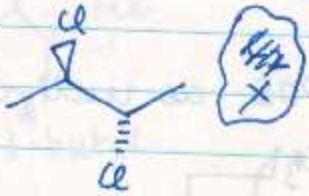
5]  C_3 C_2

6]  C_3 C_2

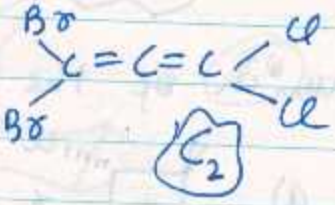
7]  C_2

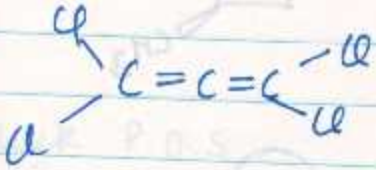
8] C_2

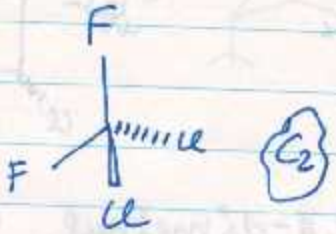
9] C_2

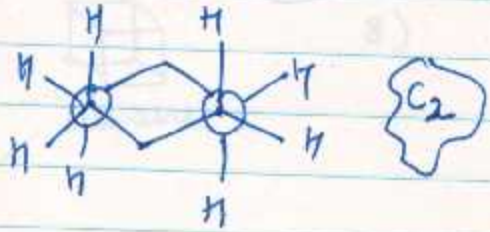
10]  X

11] C_2

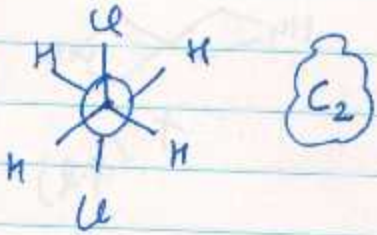
12]  C_2

13]  C_2

14]  C_2

15]  C_2

16] C_2

17]  C_2

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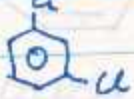
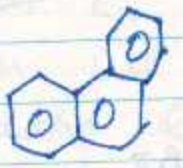
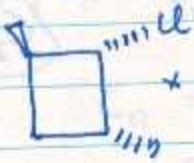
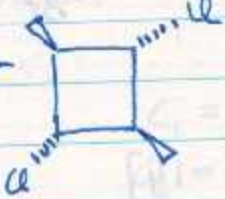
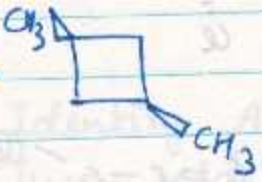
Q. Which of the following molecules have A.O.S as well as co-axial plane of symmetry.

1) a) Formaldehyde b) m-dichloro benzene  c)

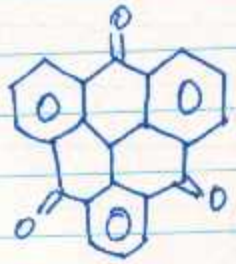
d) 

+4

Q. Which of the following cmp. has POS as well as COS

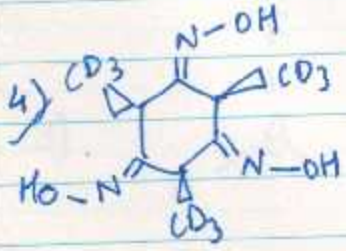
2) a)  b)  c) 

d) trans-1,3-dimethyl cyclobutane +4

3) 

a) P.O.S
b) C.O.S
c) C_3
d) C_4

+4

4) 

a) C_2
b) C_3
c) C_4
d) AOT

+4

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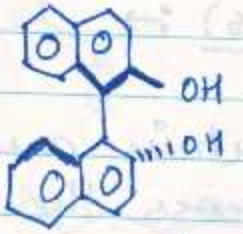
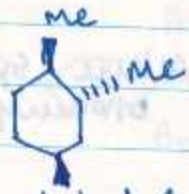
5) 

Binapthol

a) P.O.S
b) C.O.S
c) Both
d) none

+4

6) 

t-butyl

a)

b)

c)

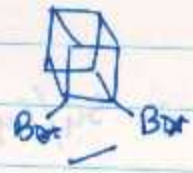
d)

+4

Q. Check P.O.S.

7)
Cubane ✓

8) ✓

9) 

✓

10)

(l.p.) ✓

11) ✓
Prismane

12) ✓
Tetrahedrane

13) Which is more stable ?

A: Cis - 1 - Ethyl - 3 - methyl cyclohexane

(A)

B: Trans - 1 - ethyl - 3 methyl cyclohexane

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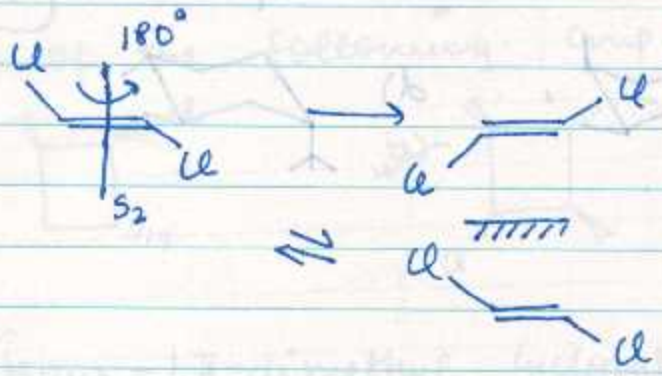
* Alternate Axis of Symmetry (A.A.O.S) :→

- If we rotate a molecule about certain axis by $\frac{360^\circ}{n}$ & if reflection taken across the 1st plane matches the face of molecule then S_n will exist.

$C.O.S = S_2$

Check for S_4 in Allene / spiro biphenyl.

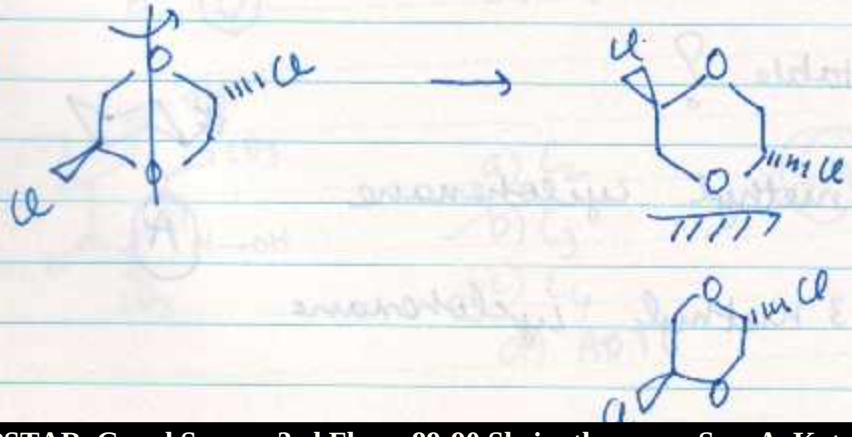
Eg,

1) 

2) $\Rightarrow S_4/C_4$

Square

3)

4) 

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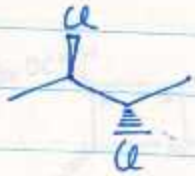
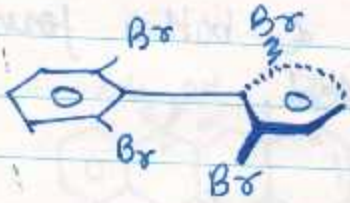
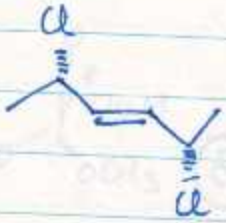
5]  → y → S_2

6] → π (S_4)

7]  → S_4

8] → y (S_2)

9] X

10]  X

* Chirality centre / Asymmetric centre / Chiral centre / stereogenic centre :

⊕ N_{abcd} , C_{abcd} , P_{abc}

✓ all the groups attached must be different ($a \neq b \neq c \neq d$)

✓ sp^3 hybridised (C, N).

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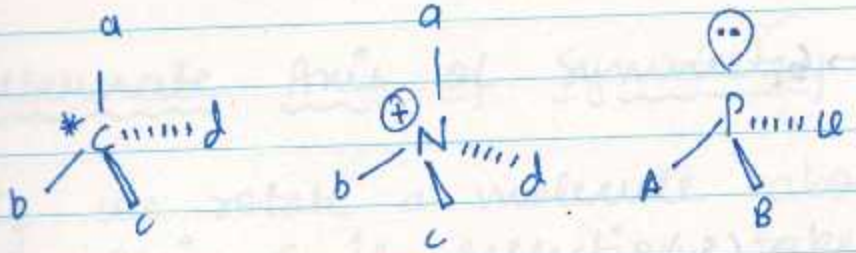
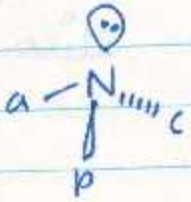


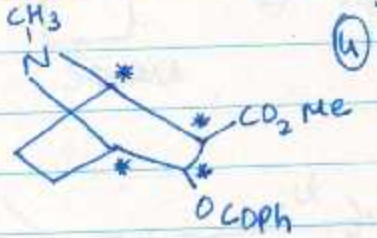
Note :

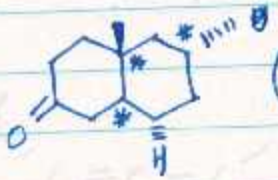


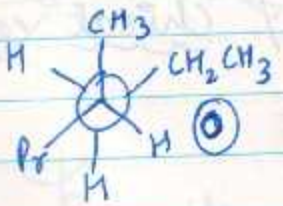
here 'N' cannot be chiral centre as flipping occurs & both forms cannot be separated.

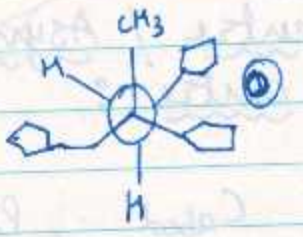
- Isotopes are considered as different groups.
- Atom cannot be sp^2 hybridised
- Focus on त्रिवार्ड & चतुर्वार्ड
- In cyclic compounds all the pathways must be different.

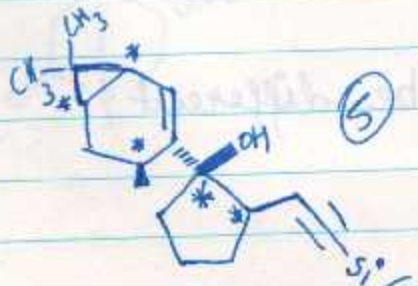
Q. count the no. of chiral carbons

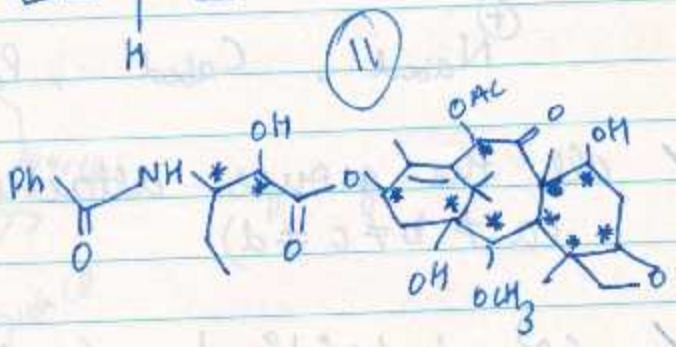
1]  (4)

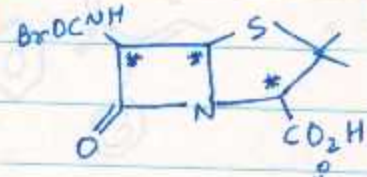
2]  (3)

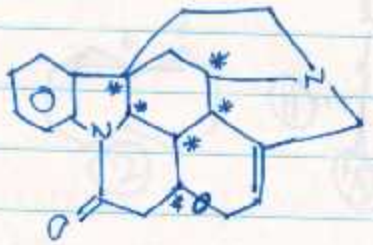
3]  (0)

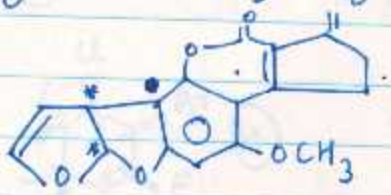
4]  (0)

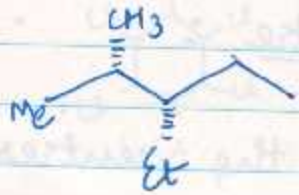
5]  (5)

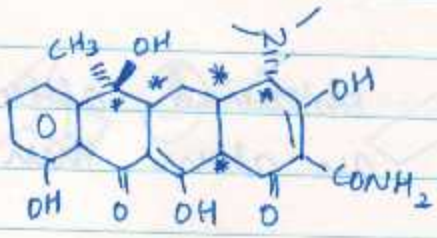
6]  (11)

7]  (3)

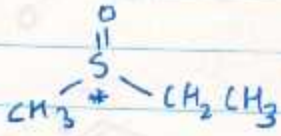
8]  (6)

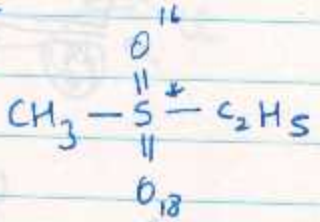
9]  (4)

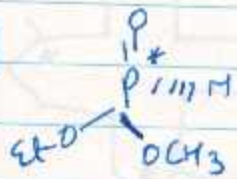
10]  (6)

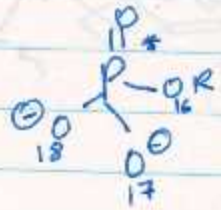
11]  (5)

Q. Identify chiral centre

1] 

2] 

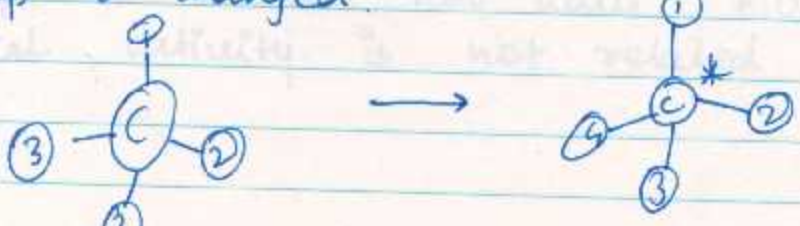
3] 

4] 

5] PO_4^{3-}

* Pro-Chiral Carbon :→

It is a type of carbon which is not chiral but converts to chiral centre when one of the group is changed.



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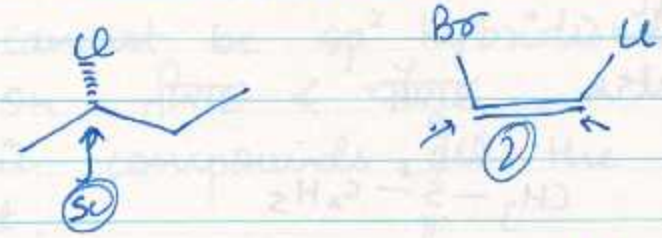
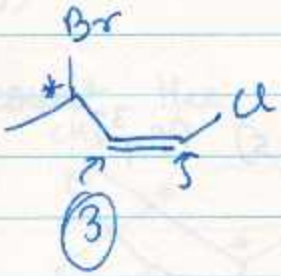
* Stereocentre :

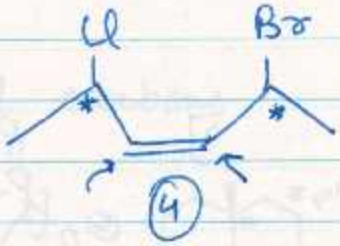
- These are the centres due to which Stereoisomerism occurs.
- When a new stereoisomer is obtained after interchanging two groups on an atom then that center is Stereocentre.



1]



2]



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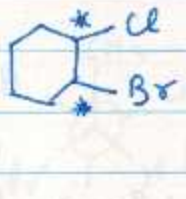

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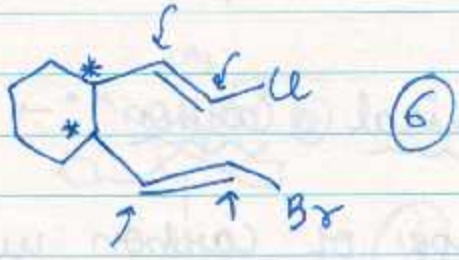

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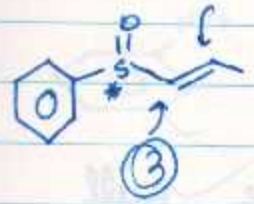

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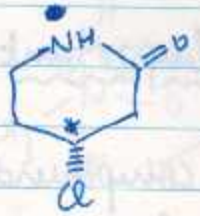

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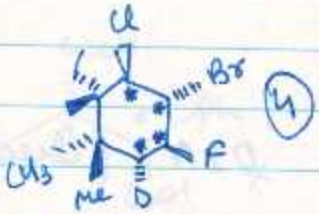

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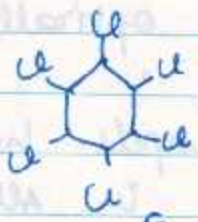

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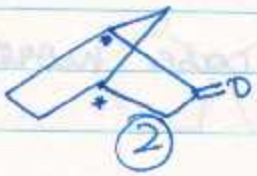

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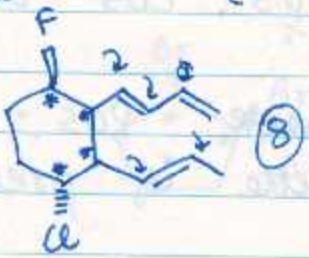

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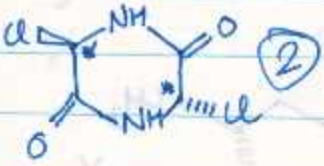

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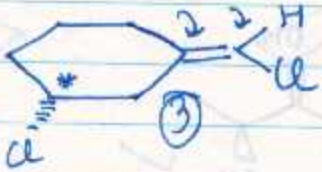

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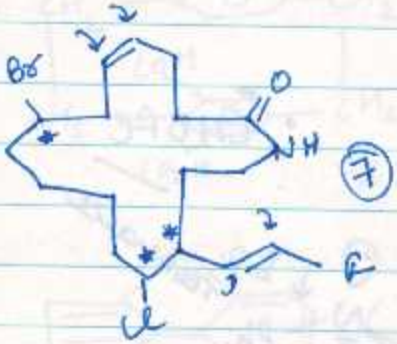

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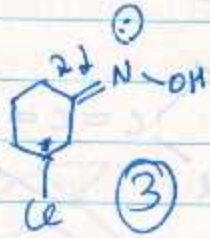

(3)

* Optical Activity / Chirality :

- These cmpds rotate the plane of P.P.L.
- Optically active cmpds are asymmetric. (chiral)
- Compound should not have P.O.S, C.O.S, A.A.O.S
- Optical activity is not related to A.O.S.

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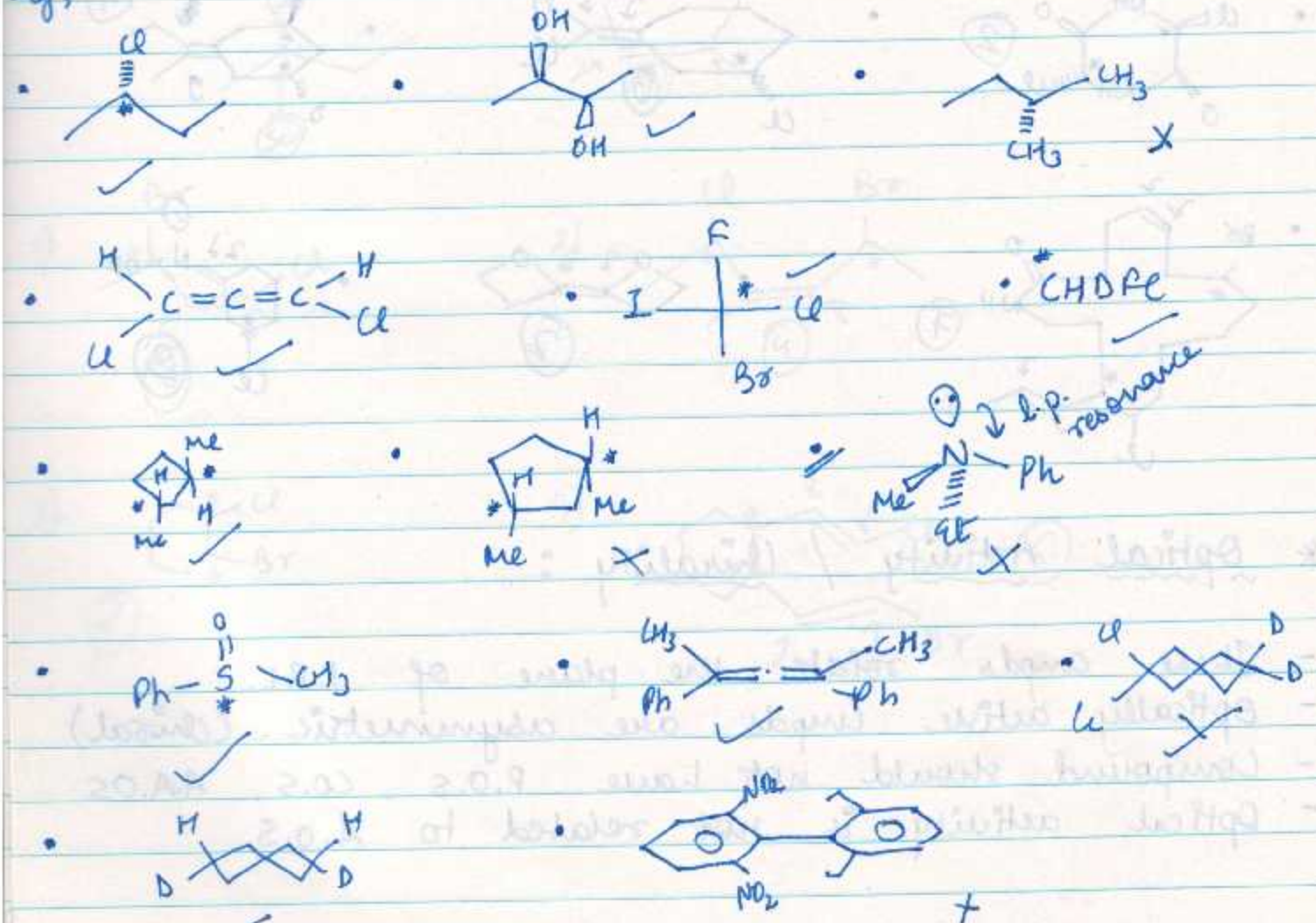
* Important points to check optical activity :

i) compounds having exactly one chiral centre will always be optiall active (OA).

ii) Most of cmpds having 0 CC are OIA (check POS, COS in Allene, spiro, phenyl).

iii) Check POS, COS in case more than one chiral centre is present.

Eg,



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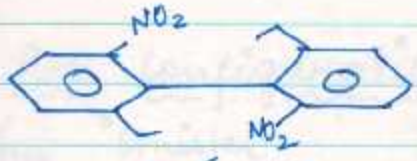
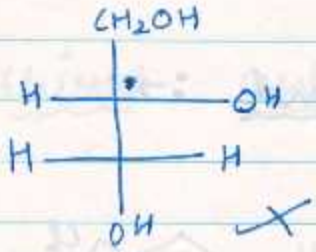
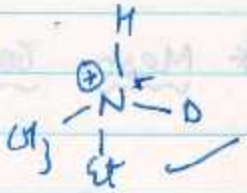
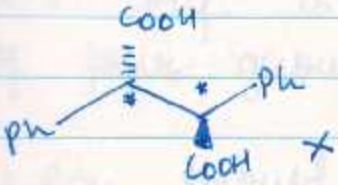
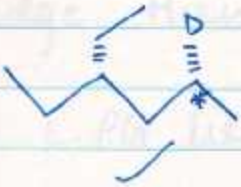
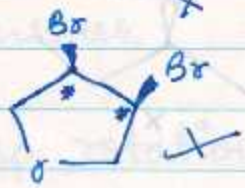


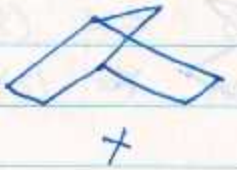


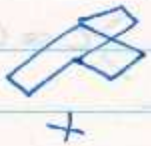


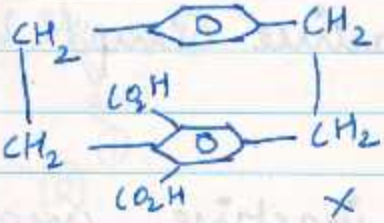


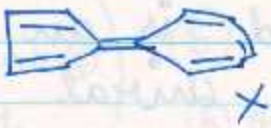


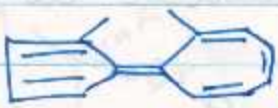


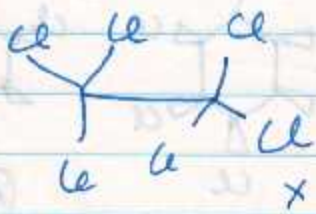


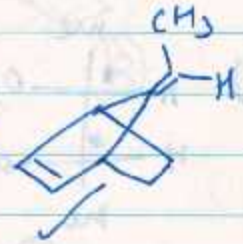


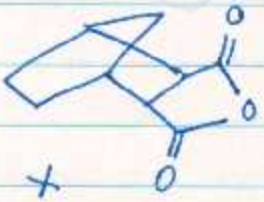


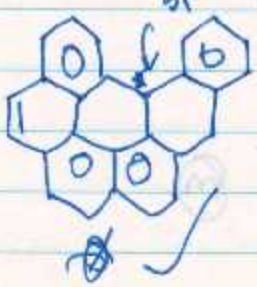




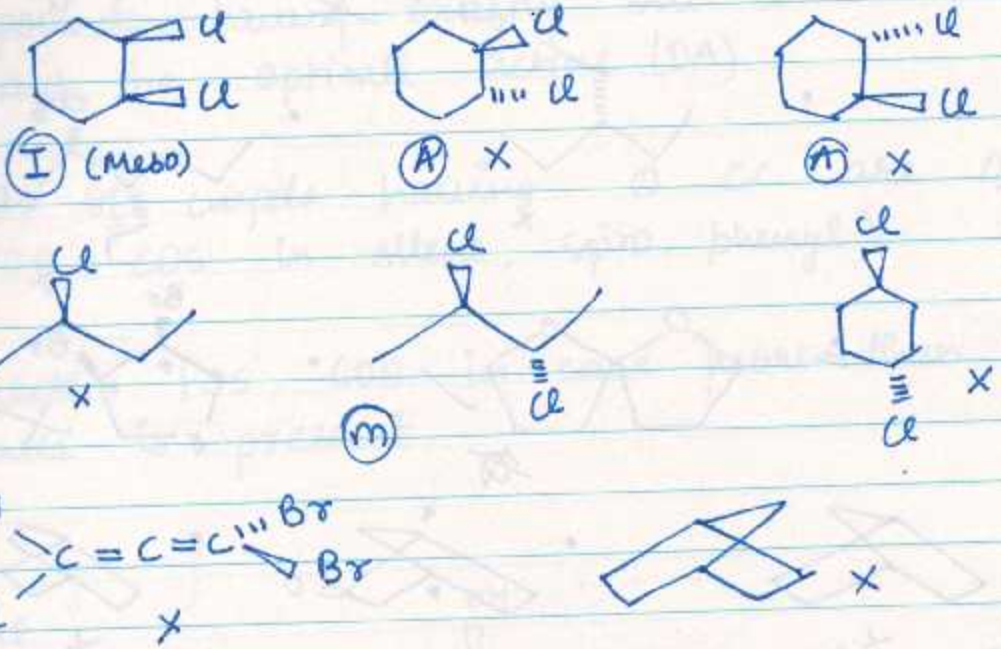






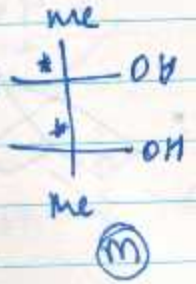


* Meso compound :→



- Meso compound is an optically inactive cmpd having at least two chiral centres.

* Meso compound is that optically inactive cmpd out of a set of stereisomers in which at least two are optically active.

1] 

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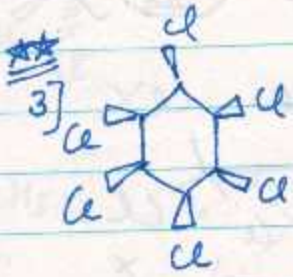
3] 
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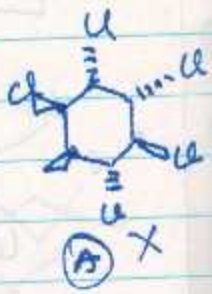
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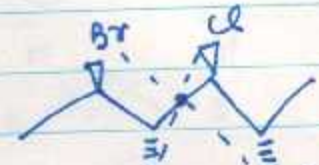
4] 

(m)

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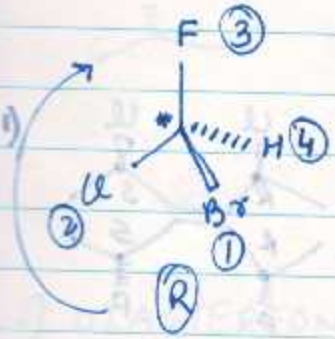
* R-S configuration for chiral centres :-

Rectus Sinister

- R-S conf. is used to designate the arrangement of four groups around the chiral centre.
- L.P.G should be at dash, if L.P.G is at wedge then reverse the normal answer.
- If L.P.G lies on plane then use 3-grp rotation.

Rectus (R) ⟹ Clockwise
Sinister (S) ⟹ Anti-clockwise



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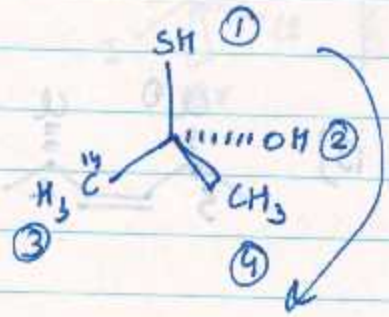

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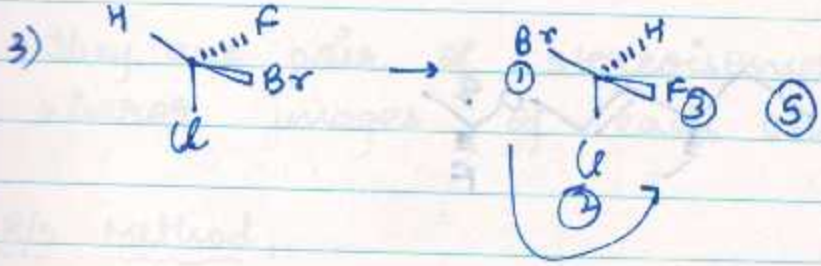

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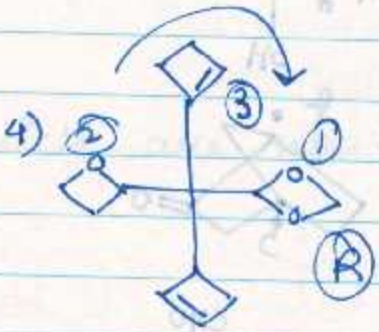

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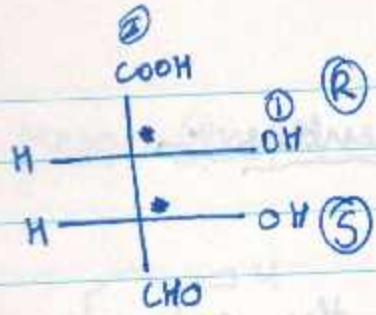
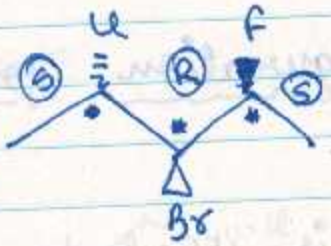
5] 

6] 

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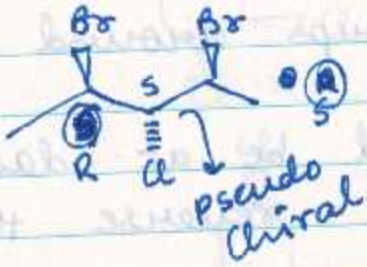
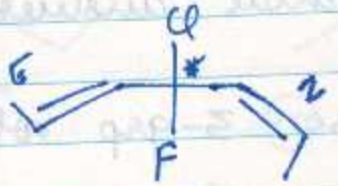
8] 

R > S (Priority)

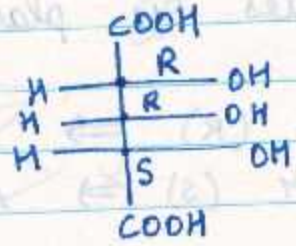
9] 

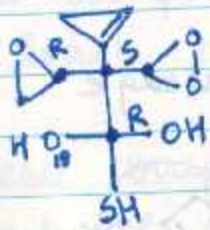
Z > E (Priority)

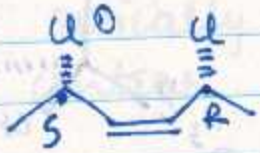
×

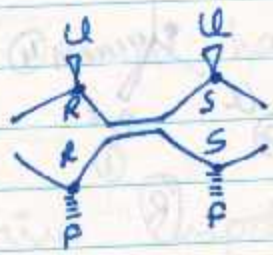
10]

R | R2R

11] 

12] 

13] 

14] 

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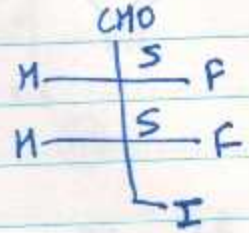
17] 

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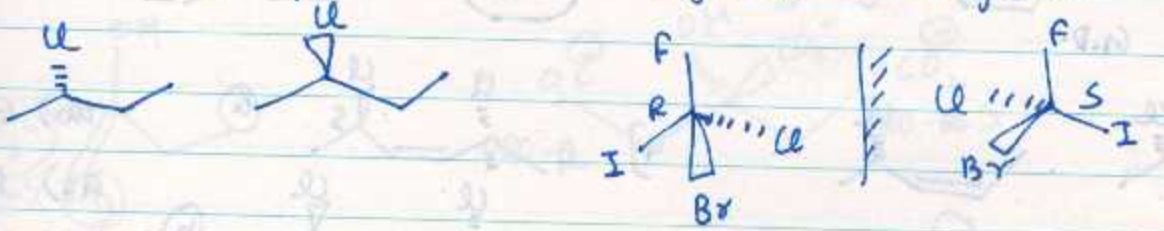
* Optical Isomers :

- Optical isomers are pair of stereoisomers having diff. optical rotation.

1] ENANTIOMERS :

- They are pair of o.i. having equal & opp. optical rotation.
- They are non-superimposable mirror images of each other.
- It is only possible in assymetric object.



2] DIASTEREOMERS :

- They are pair of stereoisomers which are non-mirror images of each other.

R/S Method,

→ If R/S conf. same ⇒ they are same

If opp. R/S + asymmetric cmpd. ⇒ Enantiomer

Opp. R/S + symmetric cmpd. ⇒ Identical / Meso

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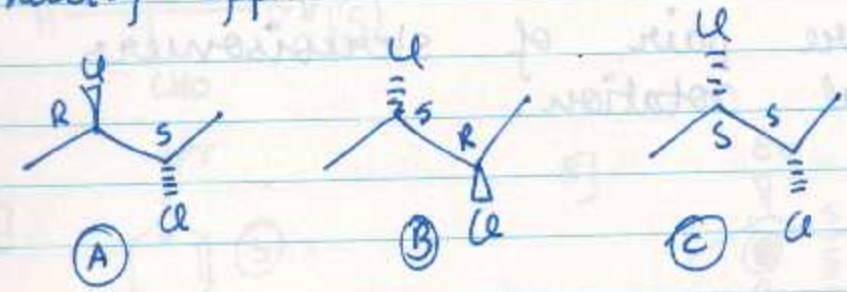
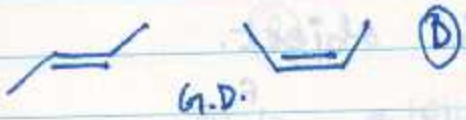
If R/S conf. neither same nor ⇒ Diastereomer.
exactly opp.

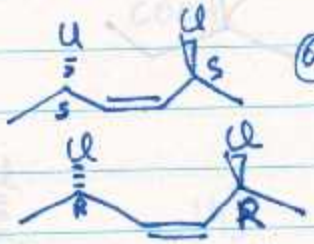


AB) Identical
AC) Diastereomer

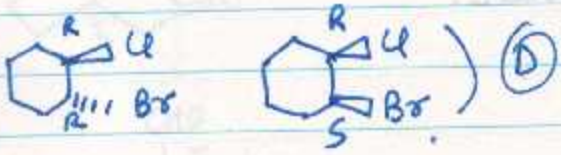
1]  D
G.D.

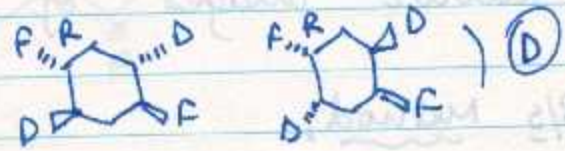
2] D

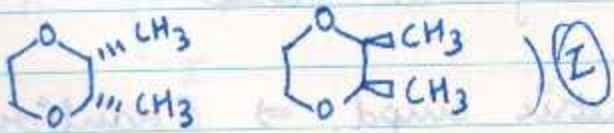
3]
D

4] 
a) ab) E
ac) D
b) bc) D
c)

*/- Diastereomers can be,
i) Geometrical I.
ii) Optical I.
iii) both

5]  D

6]  D

7]  I

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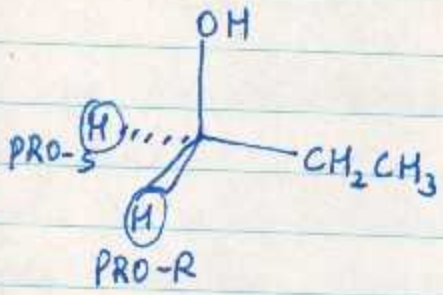
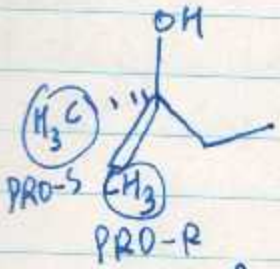
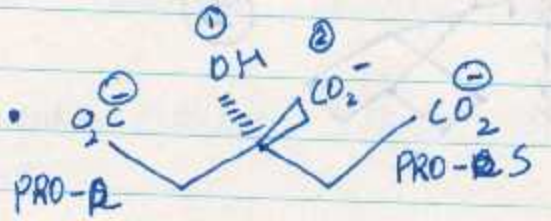
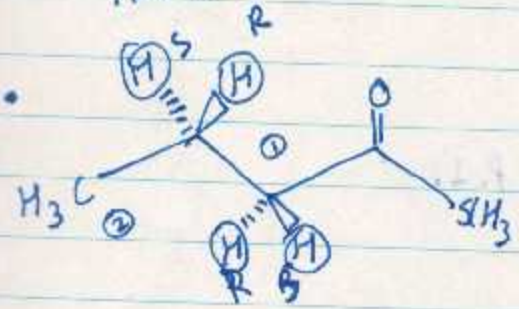
* Pro-R & Pro-S group :→

In a tetrahedral specie such as $Xabc_2$ if higher priority is assigned to one of the groups and configuration comes out to be 'R' then that group is PRO-R.









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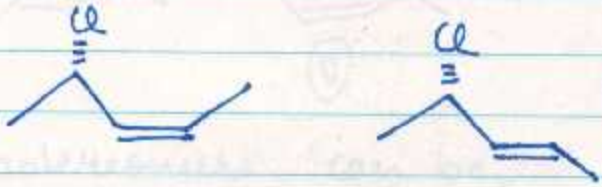
Q. Establish Relation :

1.) (E)

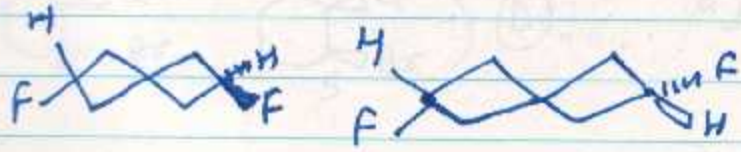
Optical isomerism is possible even without chiral centre

2. (E)

3. (I)

4.  (D)

5.) P.I.

6.  (E)

7. (E)

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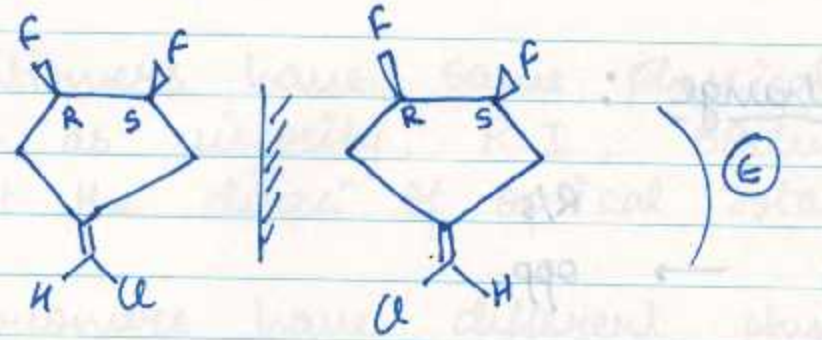
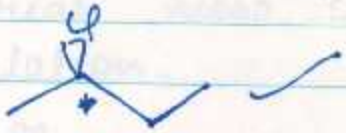
8. 

⊖ G.I. ✓

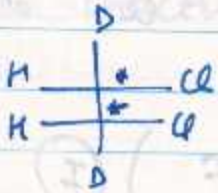
Condition to show O.I.

- Pair of stereoisomers having different α (either mag. / direc^n)

i] Cmpd. having chiral centres will show O.I.
ii] Cmpds having zero chiral centre will not show O.I.
iii] Unsymmetrical cmpds having zero chiral centre will also show O.I.

1. 

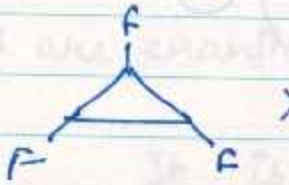
✓

2. 

✓

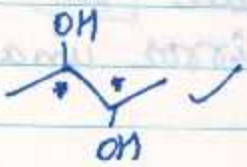
3.

X

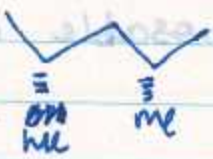
4. 

X

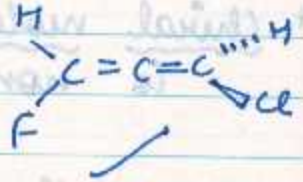
5.
X

6. 

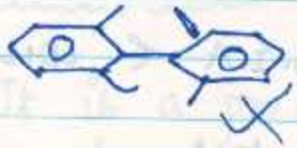
✓

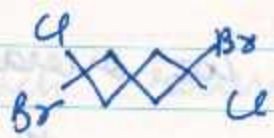
7. 

X

8. 

✓

9. 
X

10. 

✓

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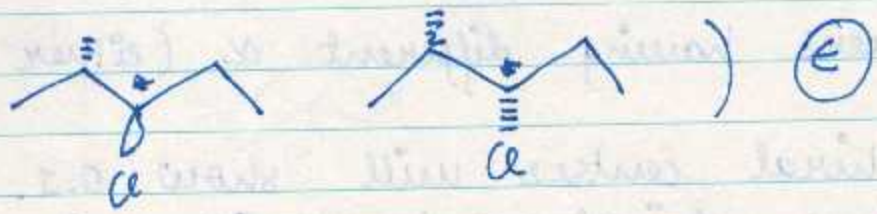
* Method of Interchange :

R/S

Odd pair interchange → opp.

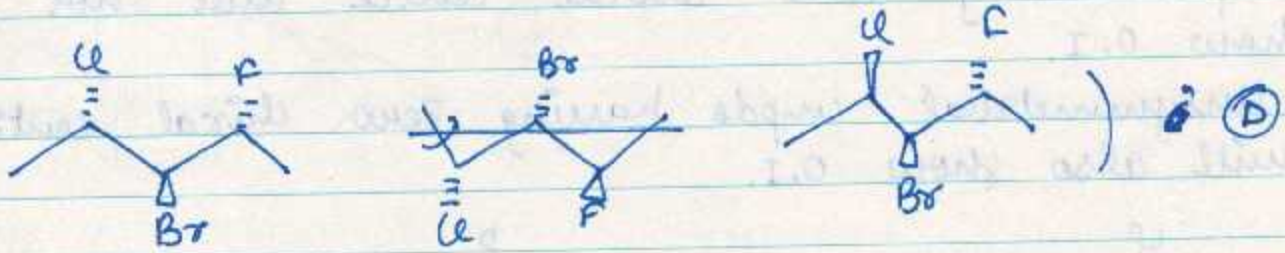
Even pair interchange → Same

•



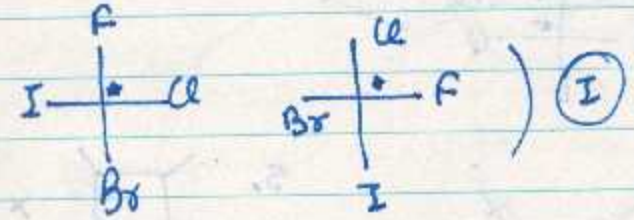
) (E)

•



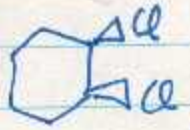
) & (D)

•



) (I)

* Chiral molecule / object : It is a molecule which is non-superimposable on its mirror image.



is a meso compound even if

coz overall it is O.I.A & contains

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- Enantiomers have same physical properties such as viscosity, R.I., boiling point, etc except the direc^{n} of optical rotation

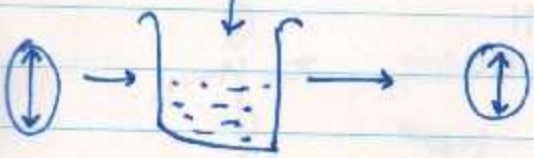
- Diastereomers have different physical properties such as B.P., etc

- Enantiomers cannot be separated by fractional distillation becoz they have same boiling points.

* Racemic Mixture :

It is equimolar mixture of enantiomers. So, it is optically inactive.
It is inactive due to external cancelation whereas meso compound is inactive due to internal cancelation.
For eg,

5g (A) + 5g (B) {A & B are enantiomers}



It is represented as
10g (d, l)
OR
10g (±)

- Racemization :

It is a process in which racemic mixture is formed.

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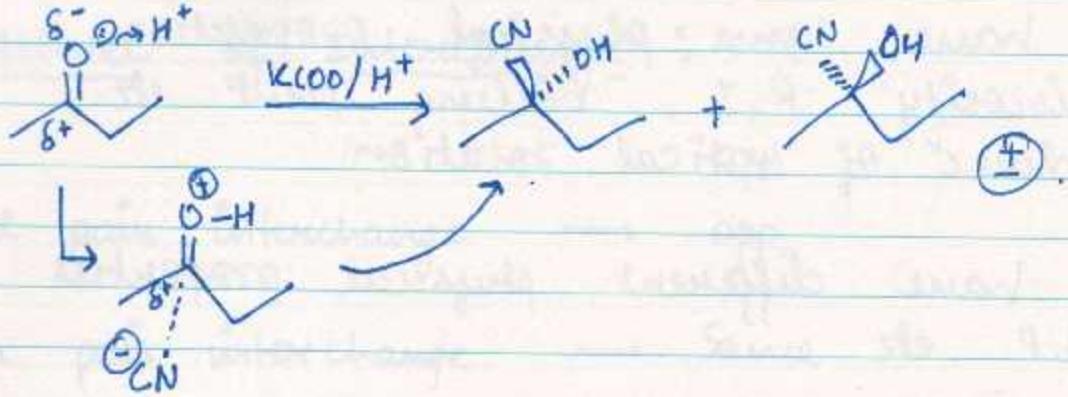
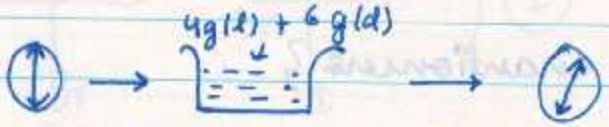


- Dextro & levo is not related to R & S.
  R(+), S(−)
  R(−), S(+)

* Optical Purity:

It is the % of enantiomeric mixture due to which optical rotation takes place.

In case single enantiomer exist in sol^n then it is said to be enantiomerically pure or optically pure.



$$\% \text{ O.P.} = \frac{\text{excess of enantiomer}}{\text{total mixture}} \times 100$$

$$\% \text{ O.P.} + \% \text{ Rac} = 100\%$$

Enantiomeric mixture can have two components.

i) % Optical purity
ii) % Racemization.

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3. % O.P. = 40% (l) Calculate composition

→ % R = 60% ⇒ 30% (l) + 30% (d)

40% (l)

70% (l) + 30% (d)

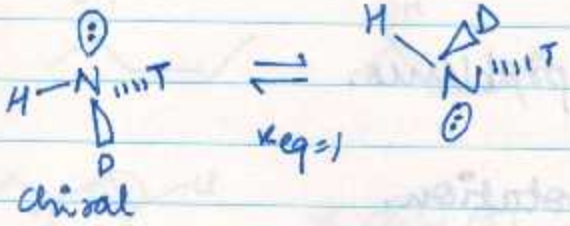
4. Optically pure mandelic acid has optical rotation of +80°. Now that acid & its enantiomer are mixed & net rotation is found to be -20°. Find % of dextro & levo forms.

→ $x \times 80 + (x+y) \times -80 = -20$ $2x + y = 1$

$y = 1/4$ $\frac{3}{8} \times 100$

Amine Inversion & Optical activity :

When 'N' undergoes flipping (with chiral centre) enantiomeric pair is formed which interconverts so rapidly that they cannot be resolved in individual enantomers. So it is optically inactive.



While counting total stereoisomers, Nitrogen (undergoing flipping) is not taken as chiral centre.

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* JEE MAINS : STEREOISOMERISM ANALYSIS

- Active, inactive, chiral, achiral, rotate ppl.
- Basics of R.S. conf^{n}
- condition to show O.I. / G.I.
- Basics of chair, boat, twist boat, etc.

** JEE ADVANCED : STERED ANALYSIS

- In depth understanding of G.I. / O.I.
- Relationship
- Calculation of total isomers.
- Dipole moment in Organic compounds
- Molecular formula based problems.
- 3-D feel of structures & rotation.

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Imp.!

* Calculation of total stereoisomers :

- Total stereoisomers include geometrical as well as optical isomers.

Case I : If no. of stereogenic areas showing O.I./G.I. is 'n' then,

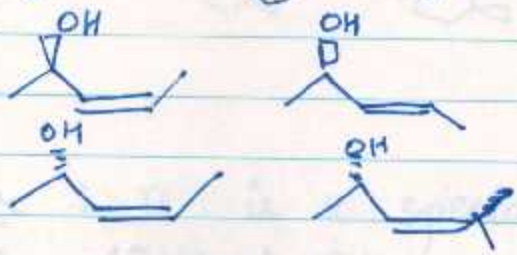
$$T.S.I = 2^n$$

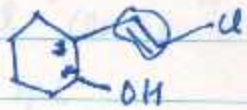
- All the isomers must be unsymmetrical.
- Optically active isomers $= 2^n$
- If total stereoisomers $= X$ then,

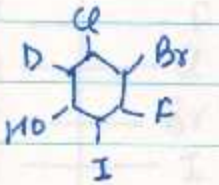
$$T.P. = E.P. + D.P.$$
$$\downarrow \times C_2 \qquad \downarrow \times 1/2$$

1) ⇒ (2)

2) $CH_3 - \overset{*}{C}H(OH) - CH = CH - CH_3$ ⇒ (4)



3)  ⇒ (4) × (2) = (8).

4)  ⇒ 2^6 = (64)

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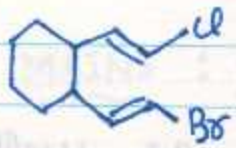
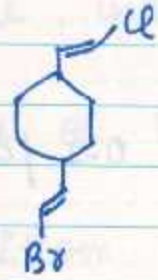
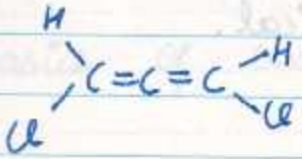
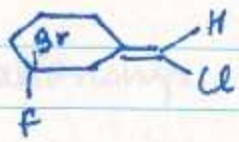
5]  = (16)

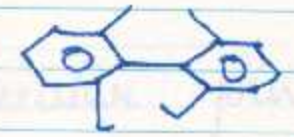
6]  = (8)

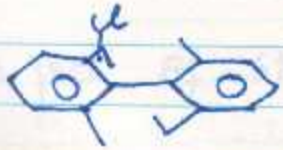
7)  = 2

8] = 4×2

9]  = 2×2

10] = (2)

11]  = 2

12]  = 4

13) (4)

14) (8)

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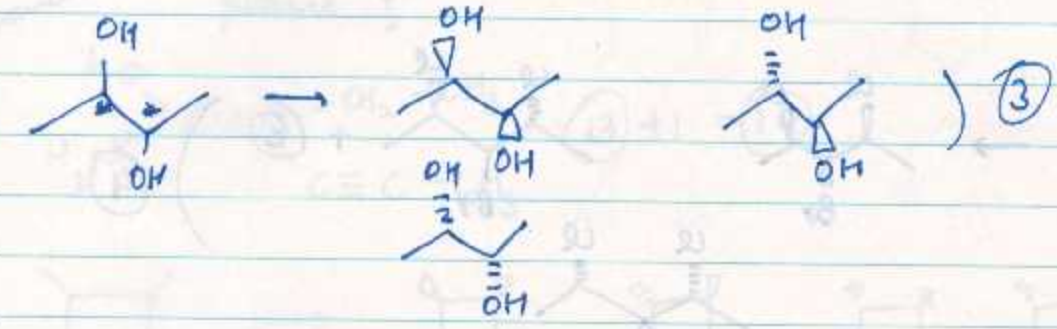
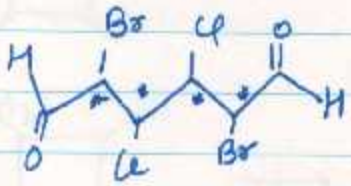
Case - II : When at least one form of the given structure is symmetrical & has even chiral centres.

a) T.S.I = $2^{n-1} + 2^{n/2-1}$
↓ active ↓ Meso

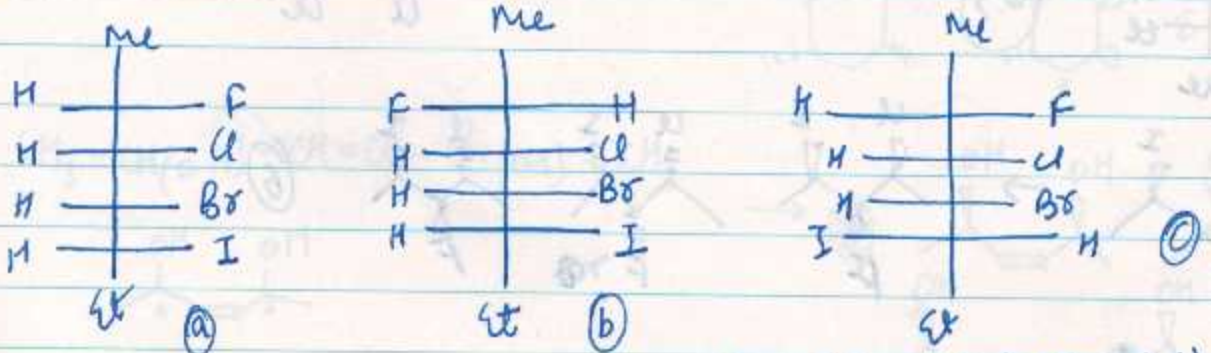
1) ) ③

2)  $2^{4-1} + 2^{2-1} = 10$

3)) ③

Note :

* Epimer : It is a special type of diastereomer having different R/S conf^n about exactly one chiral centre.



(a) (b) (c)

(a b) D & L ; (a c) D & E ; (b c) D & ≠E.

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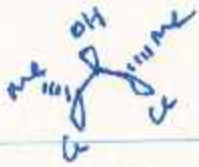
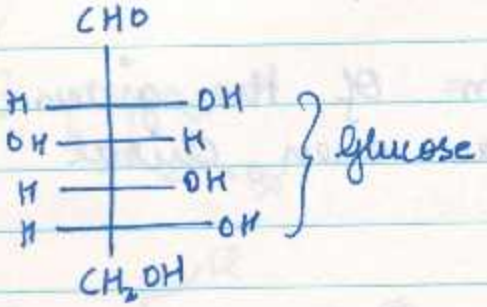
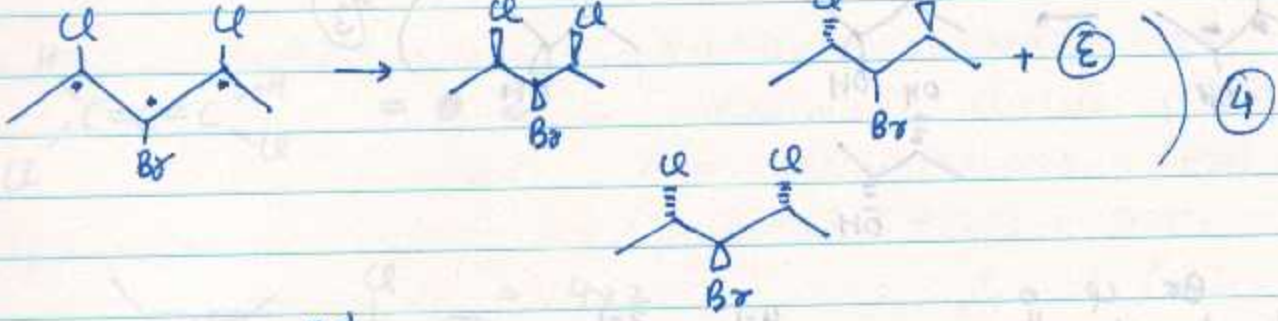




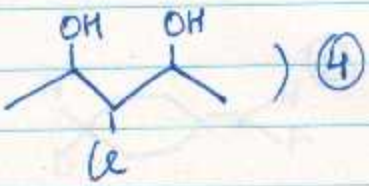
2b) Symmetrical open chain cmpd with odd chiral centre.

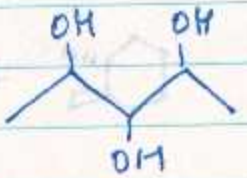
1)  (4)

$T.S.I = 2^{n-1}$

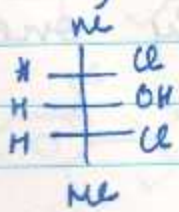
$meso = 2^{\frac{n-1}{2}}$

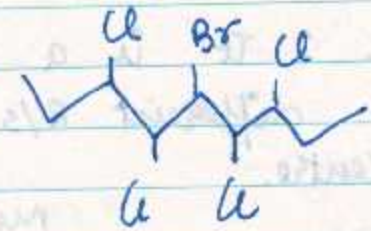
$active = 2^{n-1} - 2^{\frac{n-1}{2}}$.

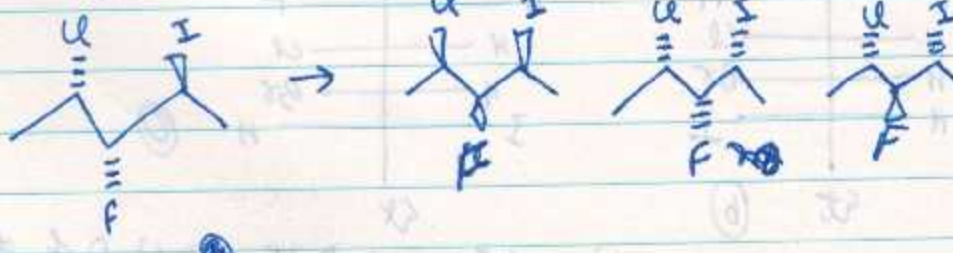
2)  (4)

3)  (4)

4) How many diastreomers?

 (03)

5)  (16)

6)  (6)

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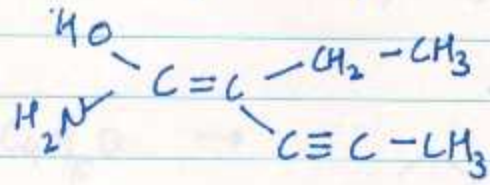
C-3 Draw & Check

1] (2)

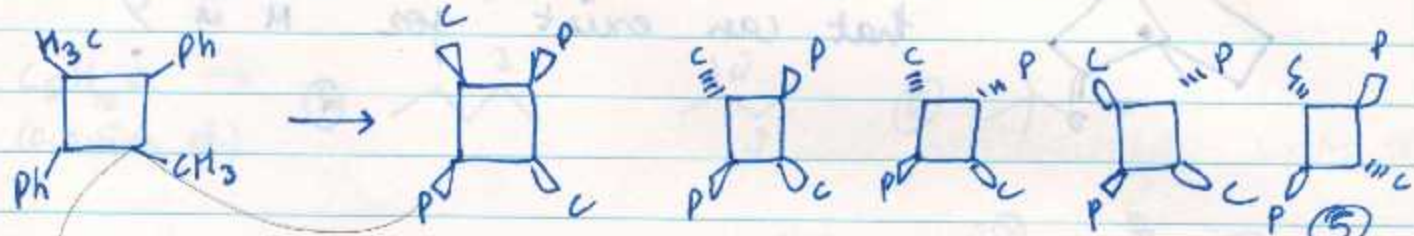
2] How many max. atoms can lie on same plane ?

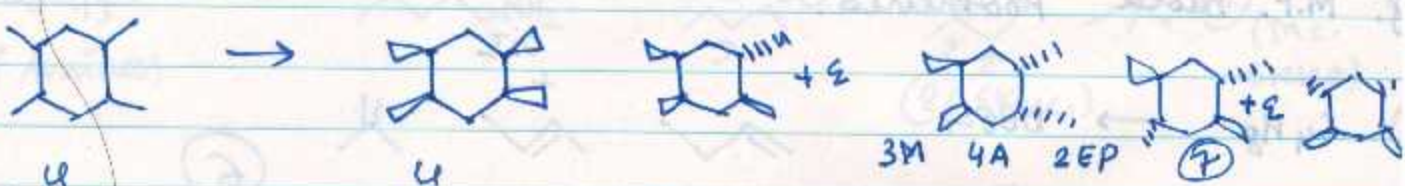
Resonance.



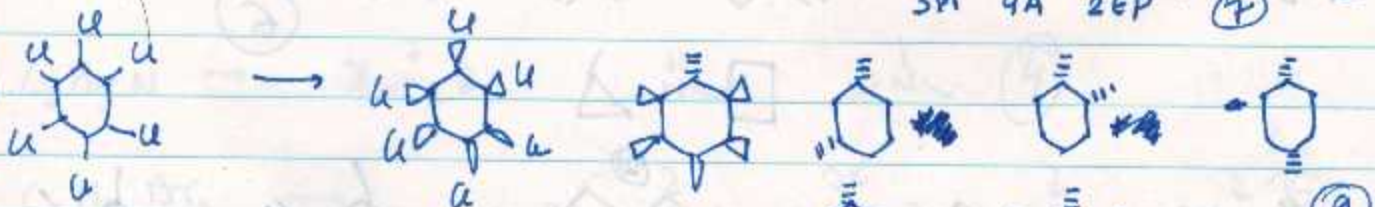
(13) + 1 = (14)

3] (4)

4]  (5)

5] 

3M 4A 2EP (7)

6]  (9)

7) $CH_3-CH(OH)-CH=CH-CH(OH)-CH_3$

(6)

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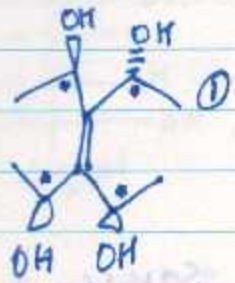
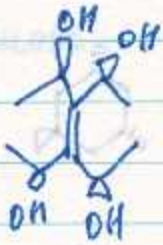
2+2+2+1+1

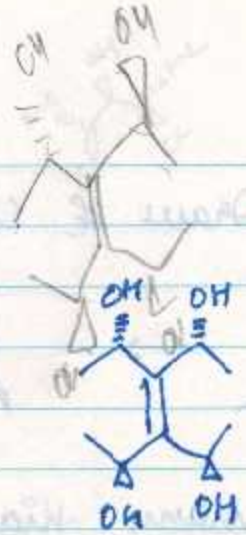
8) How many diastereomers? (5)

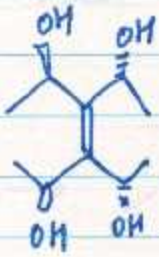


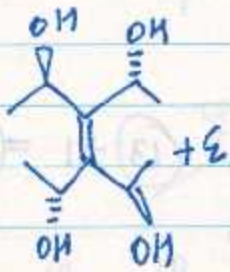
①



+E







+E

9]

the total no. of stereoisomers that can exist for M is ?

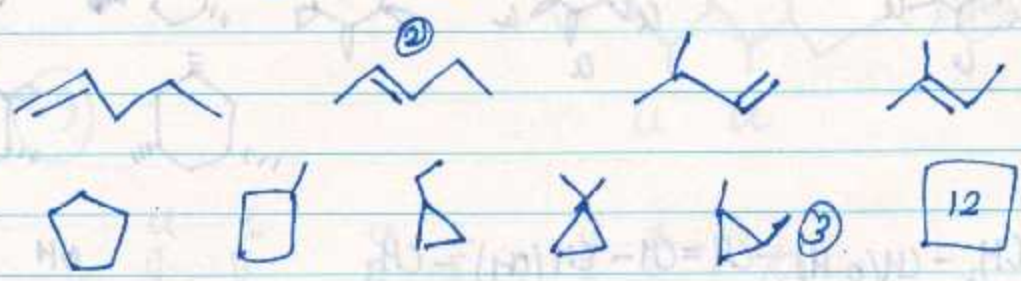
②

9. M.F. based Problems.

1) C_4H_8 ⟶ DBE=1

⑥

2) C_5H_{10} ⟶



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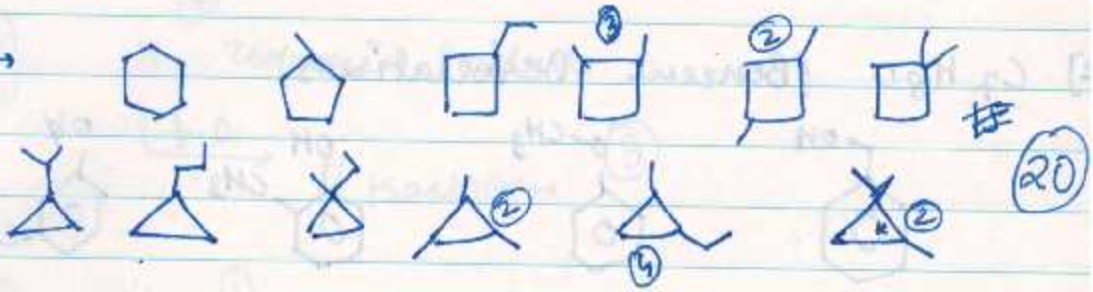
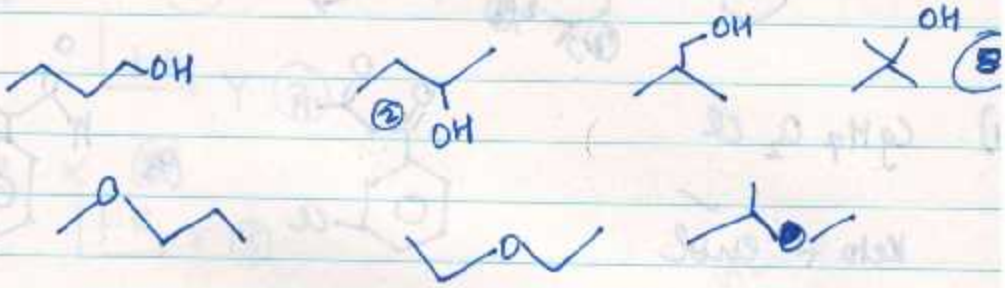
3) C_6H_{12} (cyclic) →



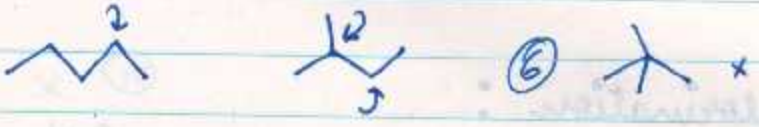
20

4) C_4H_9Cl →

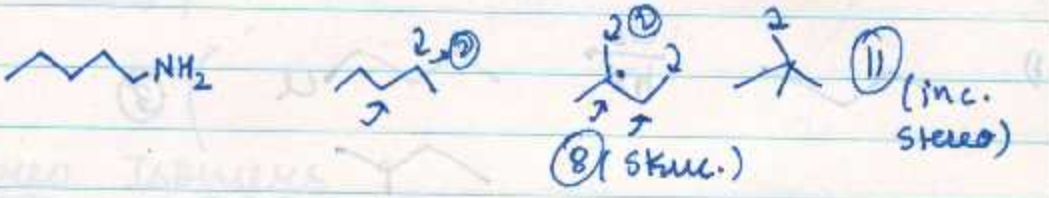
5] $C_4H_{10}O$ →



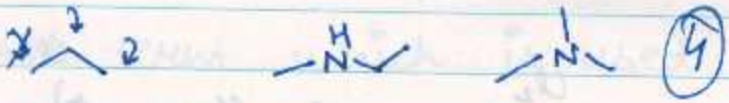
6] $C_5H_{12}O$ → (O. active al.)



7] $C_5H_{13}N$ → (1° Amines)

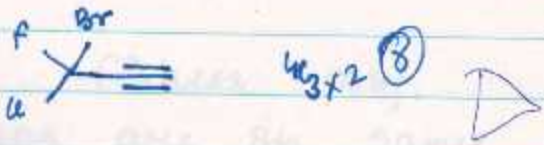


8] C_3H_9N →



9] $C_3H_5Br_3$ →

10] $C_3FClBrI$ (O. active alkynes)



11] C_4H_7Cl →

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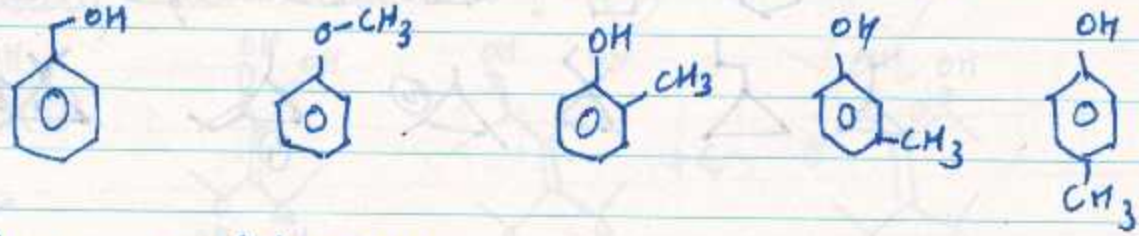
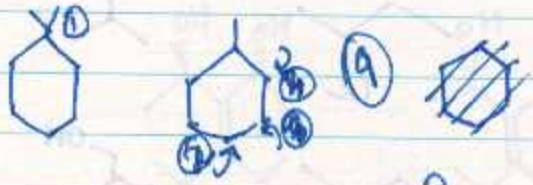
12] C_7H_8O (Benzene Derivatives) (6)

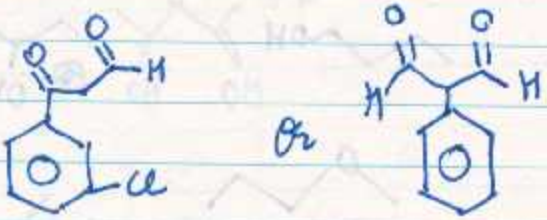
8)



13] Dichloro cyclohexane.



14] $C_9H_7O_2Cl$

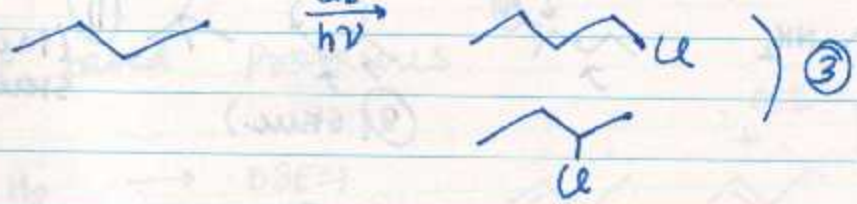


Keto $\rightleftharpoons$ enol

9. m-dis.

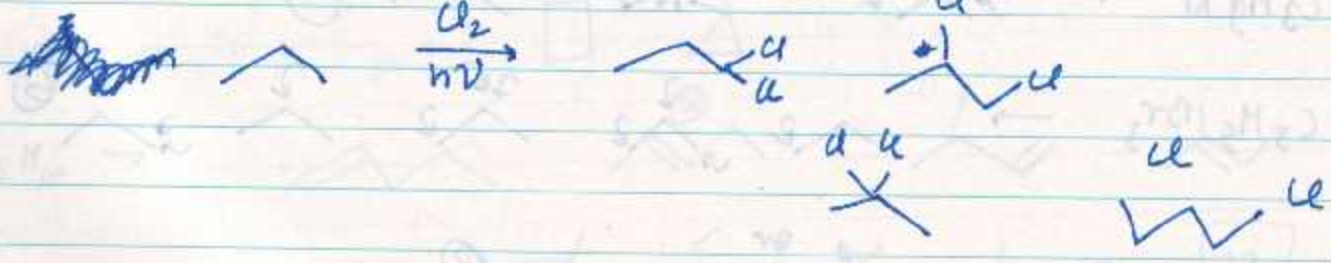
* Mono chlorination :

1)



D.C.P

2)



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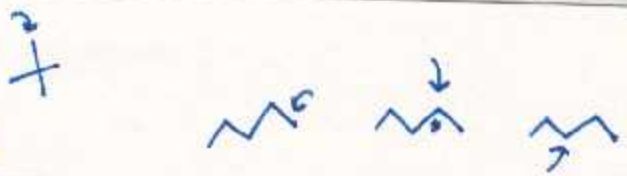


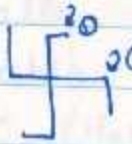
Q. $\xrightarrow[h\nu]{Br_2}$ X (4) Isomeric Products

X $\xrightarrow{f.D.}$ Y (3) fractions

Q. $\xrightarrow[h\nu]{Br_2}$ X (1)

neo pentyl bromide

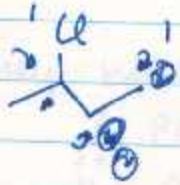
X $\xrightarrow{f.D.}$ Y (1)

Q.  $\xrightarrow[h\nu]{Br_2}$ X (3)

X $\xrightarrow{f.D.}$ Y (2)

Q. $\xrightarrow[h\nu]{Br_2}$ X (8)

X $\xrightarrow{f.D.}$ Y (5)

Q.  $\xrightarrow[h\nu]{Br_2}$ X (10)

X $\xrightarrow{f.D.}$ Y 5

* Erytho & Threo Isomers :

- It is an old term which is used to designate diastereomers.
- Mainly it is used for carbohydrates.
- It should not be expanded other type of compounds.
- It is valid for fischer proj.
- If two same grps are on same side of VL then it is Erytho isomer otherwise Threo.

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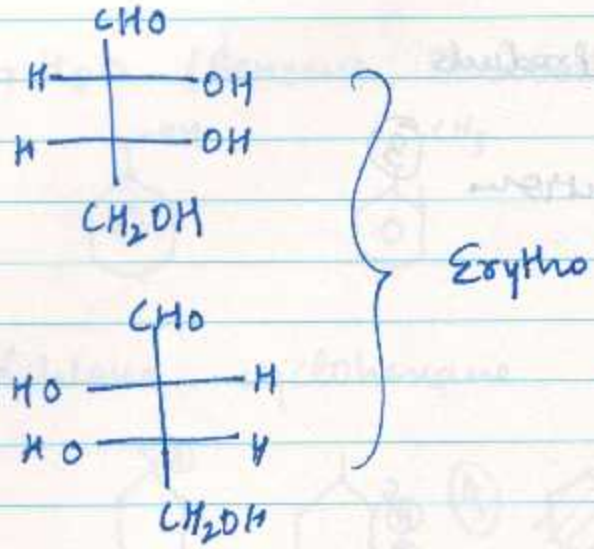
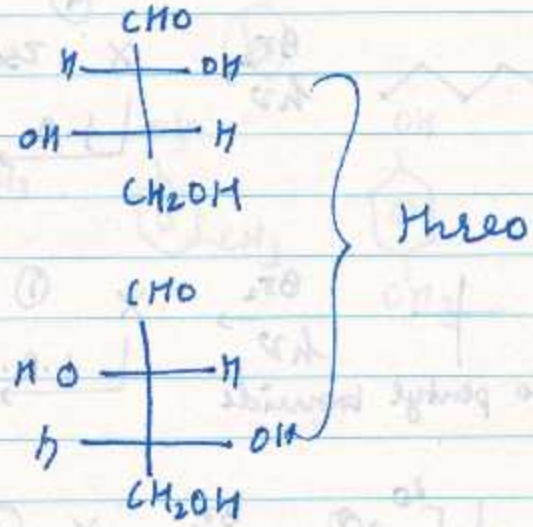
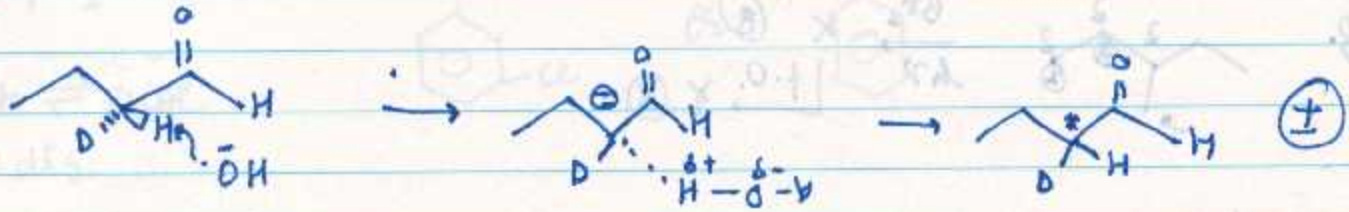
1:



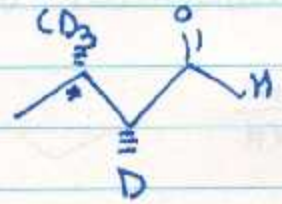


14 Q.

1)

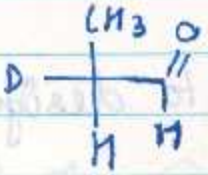


2)



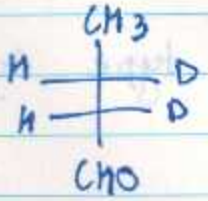
$\xrightarrow{OH^-}$ (A)

3)



$\xrightarrow{OH^-}$ (±)

4)



$\xrightarrow{OH^-}$ (A)

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* D, L Notation :

- This notation is used in carbohydrates as well as amino acids.

In Carbohydrates,

- Initially it was thought that carbs were hydrates of carbon but it was partially true.
  $C_x(H_2O)_x$

Glucose ⇒ $C_6H_{12}O_6$ But Acetic acid ⇒ CH_3COOH

$C_6(H_2O)_6$ $C_2(H_2O)_2$

↑ Not carbohydrate.

- They must be,
  i) Polyhydroxy
  ii) Optically active
  iii) Aldoses / Ketoses

We reference cmpd is D-glyceraldehyde. D/L is assigned randomly to glyceraldehyde.

D is decided w.r.t position of OH on lower most chiral centre. If OH on right ⇒ D otherwise L.

Cmpd should follow golden rule (max C atoms on VL)

It is not related to d/l.

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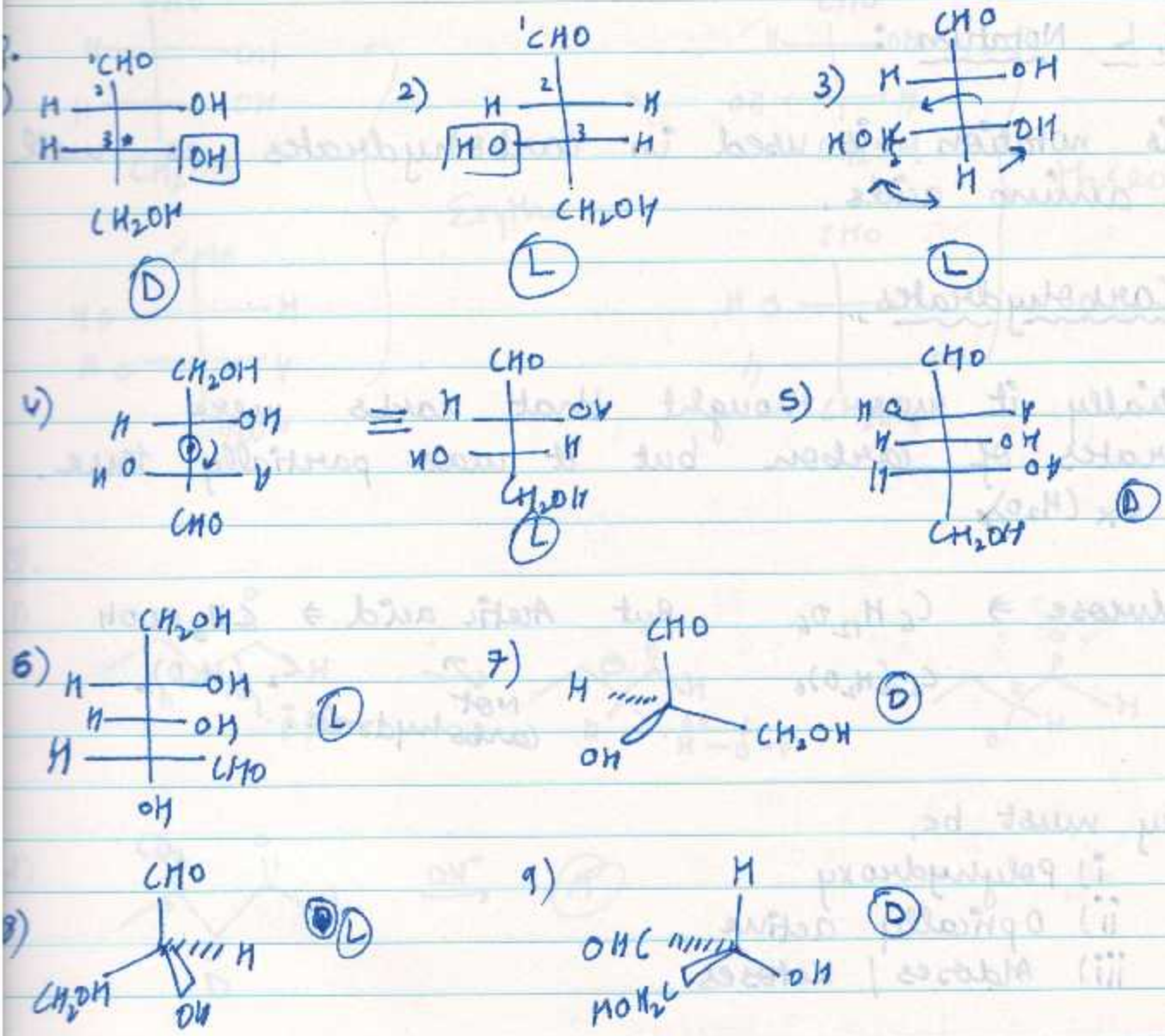
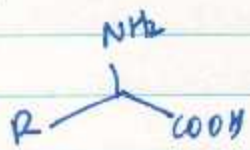


- D-glucose & L-glucose are enantiomers.

In Amino Acids,

Amino Acids they contain NH_2 as well as COOH group.



Acidic ⇒ COOH > NH_2
Neutral ⇒ COOH = NH_2
Basic ⇒ COOH < NH_2

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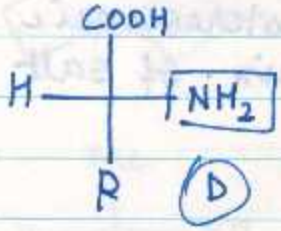
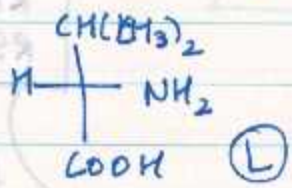
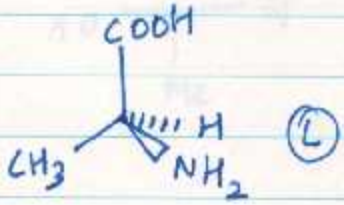
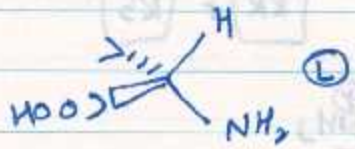
- Amino acids can be α, β, γ, etc. on the basis of relative position of NH_2 w.r.t. COOH.

- D/L is decided on the basis of position of NH_2 on the chiral centre. $NH_2 \Rightarrow$ right $\Rightarrow$ D
  $\Rightarrow$ left $\Rightarrow$ L









* Resolution of Racemic Mixture :

Separation of racemic mixture into its individual enantiomers is resolution of racemic mixture.

- Optically active compounds are resolvable coz they can form racemic mixture

active
CAR X POS
↓ chiral ↳ resolvable

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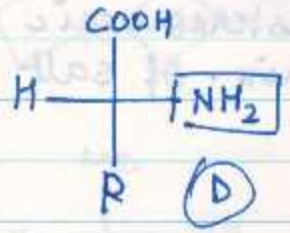
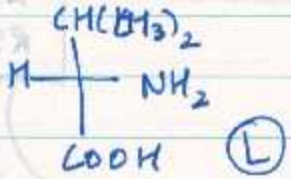
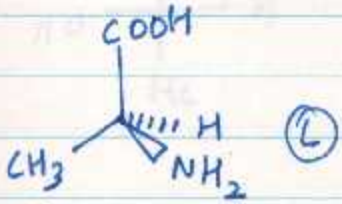
- Amino acids can be α, β, γ, etc. on the basis of relative position of NH_2 w.r.t. COOH.

- D/L is decided on the basis of position of NH_2 on the chiral centre. $NH_2 \Rightarrow$ right $\Rightarrow$ D
  $\Rightarrow$ left $\Rightarrow$ L







* Resolution of Racemic Mixture :

Separation of racemic mixture into its individual enantiomers is resolution of racemic mixture.

- Optically active compounds are resoluable coz they can form racemic mixture

active
CAR X POS
chiral ↳ resoluable

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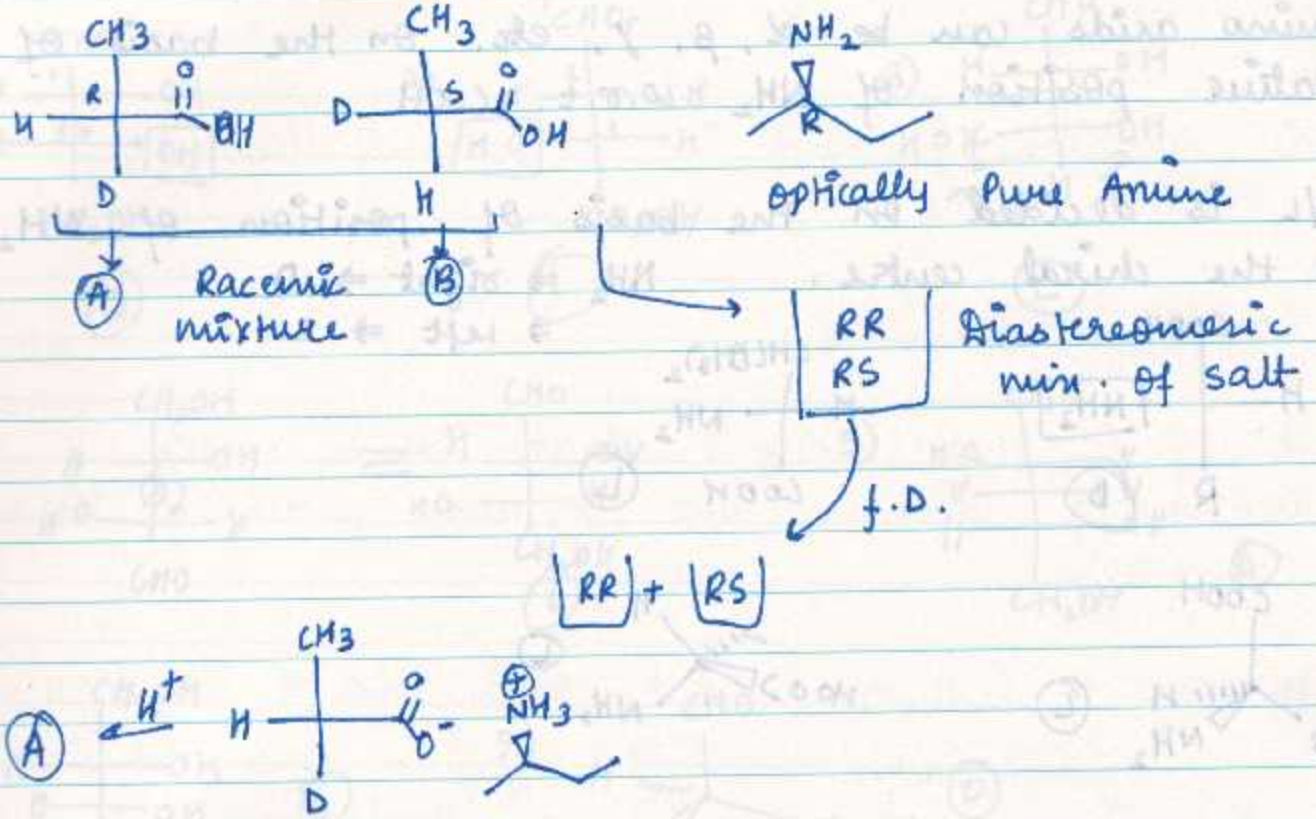
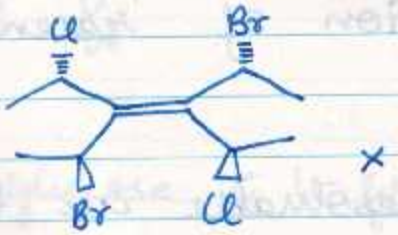


Q. Which of the following compounds are resolvable?

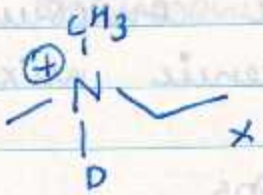
1)

2)

3) 

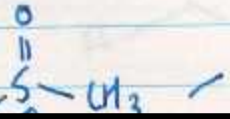
4)

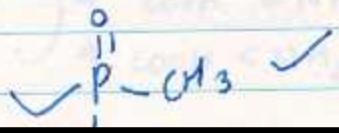
5)

6) 

7)

8)

9) 

10) 

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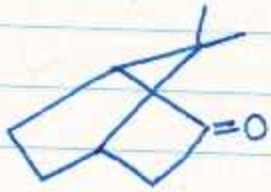
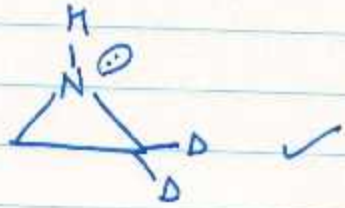
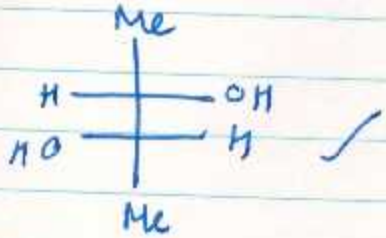
11) ×

12)  ✓

13) ✓

14)  ✓

15)  ✓